E ENGINEERING CONSTRUCTION WEEKLY

# ENGINEERING NEWS-RECORD

APRIL 11, 1940

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ANNUAL

WATERWORKS NUMBER

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# ENGINEERING NEWS-RECORD

*Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads*

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Vol. 124 *April 11, 1940* *No. 15*

| | PAGE |
|---|---|
| Contracts and Capital | 51 |
| The Week's Events | 53 |
| Reader Comment | 60 |
| Editorials | 62 |
| Lakefront Freeway for Cleveland | 64 |
| 65,000 Yards Daily at Hansen | 67 |
| Prado Dam on the Santa Ana | 70 |
| Motors for Mixers<br>GEORGE H. HALL | 71 |
| Salt Breaks Ice Bond<br>ARTHUR C. TOASPERN | 73 |
| Clearing the Floor of Services | 74 |
| What's Ahead in Construction<br>ABEL WOLMAN | 76 |
| Trailer Soils Laboratory | 78 |
| Notes on Gulf Coast Construction | 79 |
| Men and Jobs | 106 |
| Contract Unit Prices | 108 |
| Materials and Labor Prices | 110 |
| New Aids to the Constructor | 134 |
| Construction Reports | 175 |

## Special Waterworks Section

| | |
|---|---|
| Introduction | 81 |
| Water of a Bygone Day<br>M. N. BAKER | 82 |
| Billion Gallons Not Enough<br>CHARLES M. CLARK | 83 |
| Ozone Goes to Work<br>FREDERICK H. DECHANT | 86 |
| A Pikes Peak Pipeline<br>E. L. MOSLEY | 88 |
| Chlorination for Taste Control<br>WILLIAM J. ORCHARD | 91 |
| Fish in Reservoir Resist Poisoning | 92 |
| Putting a Damper on Surge<br>PAUL HANSEN AND PAUL E. LANGDON | 93 |
| Sun Ray Counts Save Sulphate<br>R. F. GOUDEY | 95 |
| Double-Deck Settling Basins<br>LORAN D. GAYTON | 98 |
| From Field and Office | 101 |

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## THIS WEEK

● While the emphasis in this issue is on waterworks (Ten Articles), a good diversity of subject matter is to be found in the pages preceding the special section. Highways and bridges are subjects covered in "Lakefront Freeway for Cleveland" on p. 64. Articles on Hansen and Prado dams and on the application of electric motors to concrete mixers furnish important data on construction equipment. Building construction receives attention in a story on the new Ford tool and die shop. Turning to the scientific end of civil engineering, there is an article on a traveling soils laboratory on p. 78. To round things out, Abel Wolman presents an expert analysis of construction business trends and possibilities.

● Twenty-odd pages are devoted to waterworks, in recognition of the approaching convention of the American Water Works Association in Kansas City. The theme of the section, "Innovations in Water Supply Practice" is introduced by a contrast of present-day water with that which was available a century ago. M. N. Baker, eminent water supply historian and retired member of *ENR's* staff, goes deep into the past to tell about the horrible stuff that once was supplied to the citizens of London. The innovations cover such outstanding practices as the use of ozone, ultra-violet rays and breakpoint chlorination.

## THINGS TO COME

MOBILE is building a vehicle tunnel under the river to cut off seven miles of the present distance to points east of the city. The tunnel in design shows interesting departures from past practice. Its construction, which is now in its most active stage, will be described in the April 29 issue.

**The woman's angle!** News-Record devotes a lot of space every year to the construction job, but rarely does a construction town story creep into its pages. The next issue will contain a human, green-shuttered, flowers-in-the-garden story of home life in the camp at Bartlett Dam—by a construction man's wife.

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ENGINEERING NEWS-RECORD

# NEWS

Volume 124 APRIL 11, 1940 Number 15

## *Typhoid Reported Again At Manteno, Ill. Hospital*

Typhoid fever has been reported again at the Illinois state hospital for the insane at Manteno, where more than 50 deaths occurred last year from that disease (*ENR* Oct. 26, 1939, p. 517). Two cases were reported, both being isolated immediately. It is stated that recent tests of the hospital water supply by the state board of public health have shown the water to be safe.

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## *Charles Clark Made Head Of New York Water Board*

Charles M. Clark, deputy chief engineer of the New York Board of Water Supply, was appointed chief engineer on April 10 to fill the vacancy caused by the recent death of Walter E. Spear. Clark, author of the leading article in the Waterworks Section of this issue, has been with the city for the last 47 years. In 1912 he was named engineer of the Croton Division and later department engineer to bring the Catskill Aqueduct to its full capacity. When additional water was to be obtained from the Delaware-Roundout sources in 1936, he was appointed deputy engineer. Roger W. Armstrong is to take over Clark's old duties.

• • •

## *Special Pollution Board Organized at Boston*

A special commission to supervise the $10,000,000 project to eliminate pollution in Boston harbor and the Charles River has been organized with Eugene C. Hultman, chairman of the Metropolitan District Commission at Boston, head. Other members are: Arthur D. Weston, chief engineer of the state department of public health; Joseph P. Dever, director of the sewerage division of the metropolitan board; Neil A. McDonald, of Quincy, and Thomas R. Bateman, of Winchester.

The district commission has received authority to begin preliminary work on the project and, on receipt of a federal grant and payment from the various municipalities concerned, to proceed with the construction work.

**NEW DEAN OF GRADUATE SCHOOL AT M.I.T.**

JOHN W. M. BUNKER, graduate of Brown University, who organized a new laboratory in sanitary engineering at Harvard University in 1911, has been appointed dean of the graduate school at Massachusetts Institute of Technology to succeed Harry M. Goodwin, who is retiring in June after 50 years as a member of the M.I.T. staff. The appointment of Nathaniel McL. Sage, former vice president of the Morton C. Tuttle Co., Boston, as director of the division of industrial cooperation is another change at M.I.T. Sage has been acting head of that department since the death of Charles L. Norton last fall. That Harold K. Barrows, widely known for his consulting work in hydraulics, flood control, water supply and power development, will retire from the civil engineering department to become professor emeritus after 31 years on the Institute staff, has also been announced.

## *Panama Lock Fund Now Before Senate*

**Committee approves $15,000,000 for work; no increase for flood control or navigation**

The War Department civil functions bill placed before the Senate by the appropriations committee, April 9, included a $15,000,000 item for start of work on a third set of Panama locks but no increase for flood control and navigation as had been recommended by a sub-committee. However, since the Senate committee on commerce reported a bill authorizing about three times as much money as in the House version, the Corps of Engineers is still expected to have a large volume of work.

In passing the bill, the House followed the budget recommendation of $25,000,000 for new river and harbor work and $70,000,000 for general flood control

*(Continued on p. 56)*

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## *Toll Bridge Refinancing Condemned by SEC*

Characterized as "a serious danger to the investing public," a plan for reorganizing the San Francisco Toll Bridge Co. which owns the San Mateo-Hayward Bridge has been severely criticized in a report by the Securities and Exchange Commission to a federal district court in California. Capitalized in 1929 at $9,882,374, the company now has a value, according to the SEC, of $2,111,000 and earnings of $180,000 a year. A proposed new bond issue would require $279,700 in interest charges; the plan also contemplates A and B class stock.

When the San Mateo Bridge was built in 1928 (*ENR*, Nov. 8, 1928, p. 686) it was the longest highway bridge in the world, 7.1 miles. Except for five steel truss spans it is of concrete pile trestle type, and particularly notable for the fact that its deck slabs are precast units.

# BRIEF NEWS

AT LEAST 155 American cities are now using parking meters in congested business and residential areas, the International City Managers' Association has reported. About $3,470,000 was obtained from meters in 1939 by 102 cities that reported revenue figures to the Association. Oklahoma City, Dallas and El Paso are the parking meter pioneers, installing meters in 1935.

A COOPERATIVE plan, beginning next fall, under which juniors and seniors in the school of engineering at North Carolina State College, Raleigh, N.C., will alternately attend classes and work in industries allied with their college work, has been announced by Blake R. Van Leer, dean of the school of engineering.

PITTSBURGH'S $1,000,000 incinerator was placed in service early this month.

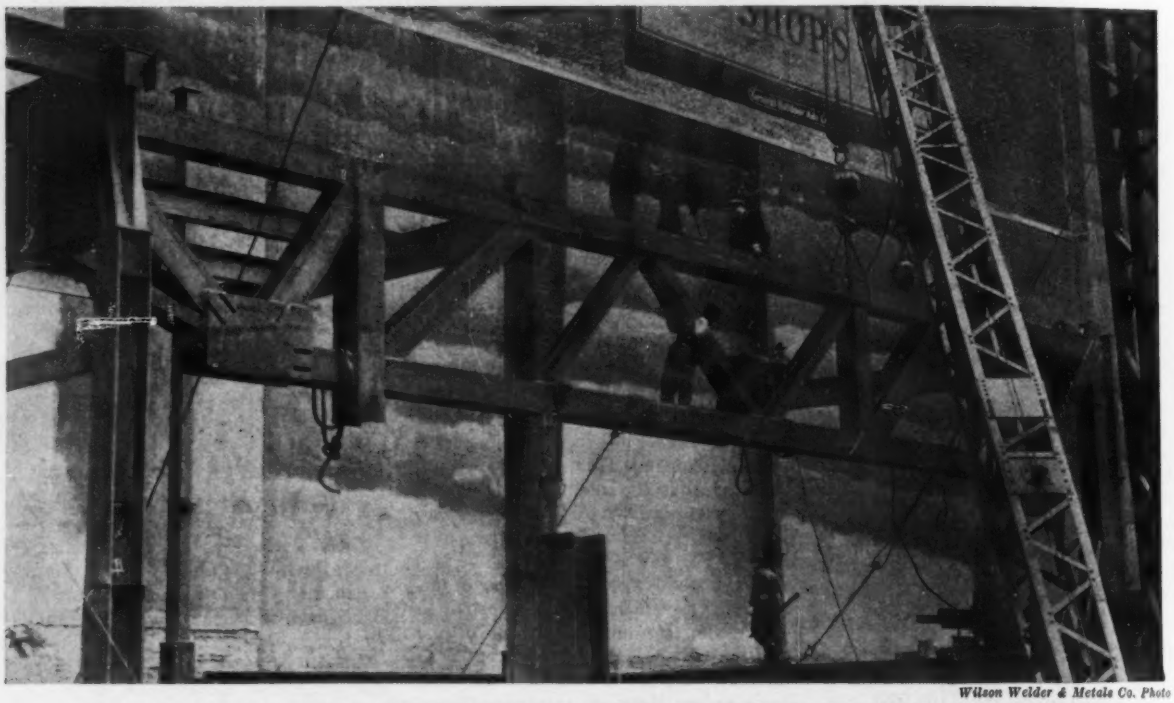
A SEWER construction and repair program to cost between $800,000 and $1,000,000 and to employ about 500 men has been approved for Indianapolis, Ind. The project, to start in about 90 days, will include work in all parts of the city on both storm and sanitary sewers.

DISCOVERY on March 26 of a fault or zone of shattered rock that diagonally crosses Friant Dam site means considerable delay in completing excavation at the critical point where diversion is to be made. June 1 was the date tentatively set for starting to place concrete in this important structure of California's Central Valley project. Now, because of the fault and some increases in excavation elsewhere, the middle or the end of July is said to be more likely the date when concreting can start.

• • •

## *Last Tunnel Holed Through For Pennsylvania Turnpike*

Holing through of the Allegheny Mountain tunnel on the Pennsylvania Turnpike on April 2 marked completion of rock work for the seven tunnels on the toll superhighway being built between Pittsburgh and Harrisburg. Sideling Hill tunnel, 6,596 ft. in length and the longest of the seven tunnels, was holed through on Mar. 28. The Rays Hill tunnel, 3,393 ft. in length and the shortest of the seven tunnels, was holed through first on Jan. 22.




*Wilson Welder & Metals Co. Photo*

**HEAVY TRUSSES CHARACTERIZE WELDED FRAMING OF AIRLINES TERMINAL IN NEW YORK**

ERECTION is proceeding rapidly in New York City on what is called the world's largest terminal devoted exclusively to air travel. Situated on the corner of 42nd St. and Park Ave., opposite the Grand Central railroad terminal, the airlines terminal building, 105x200 ft. in plan and extending four stories above the street and four below, is notable for its all-welded frame.

In the 1,365 tons of steel required, two trusses and several plate girders are the most interesting pieces. The trusses have a span of 70 ft. and weigh 30 tons each. They are fabricated of rolled sections throughout, top and bottom chords being 14-in. H's. The necessity for framing several web members into the bottom chord at each end required the use of large gusset plates attached by means of slot as well as fillet welds; elsewhere joints in the trusses are of butt type. Each end reaction amounts to 800,000 lb., while maximum tension on the bottom chord is 1,800,000 lb. The trusses support a total of five floors, three floors above the top chord and two floors below, the bottom one being supported from hangers. The largest plate girders have a span of about 50 ft. and weigh 6 tons each.

On the 42nd St. side of the building the ground floor will be devoted to a number of stores and to a newsreel theatre. John B. Peterkin is the architect, the structural steel was designed by Jacob Langfur, and the welding designs executed by Gilbert D. Fish. Lehigh Structural Steel Co., Allentown, Pa., fabricated the steel, which is being erected by the Lehigh Construction Co., New York City. Bethlehem Engineering Corp. is the general contractor.

## Railroad Granted Right To Operate Truck Lines

The right of the Minneapolis & St. Louis R. R. to go into the trucking business was upheld late last month in the federal district court at Minneapolis when the district judge ruled that the Railroad and Warehouse Commission had erred in denying the railroad's petition for four truck lines running from the Twin Cities to Albert Lea and from the Twin Cities to Winthrop. The judge held that public necessity was shown in the application and ordered the applications granted.

• • •

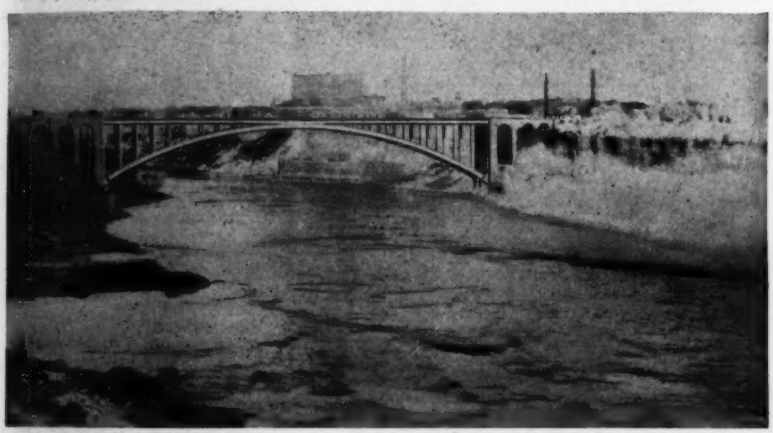
## Spokane Building Code Upheld in Hospital Case

The Washington State Supreme Court this month upheld constitutionality of the city of Spokane's building code, and ordered an osteopathic physician, who had won a lower court decision on grounds that the ordinance was void, to secure a hospital permit before operating such an institution. The physician claimed that it was not necessary to secure a permit since the hospital was formed before the ordinance was passed. The high court ruled that the physician was not forbidden from operating a hospital but only required to use a building of a certain character.

• • •

## Arkansas Bridge Fund Act Held Unconstitutional

Act 174 of the 1939 session of the Arkansas state legislature, which authorized the Red River Bridge District commissioners to turn over to the state of Arkansas about $11,000 for paving the Index-Ogden road on U. S. Highway 71, has been held unconstitutional on the ground that it is local legislation. The court held that the money should be turned over to the state for use only in maintenance of the bridge on U. S. Highway 71 spanning Red River at Index, the decision being handed down in a friendly suit filed by the bridge commissioners to test legality of the act.



**PROPOSED NIAGARA BRIDGE TO REPLACE SPAN DESTROYED BY ICE**

SHOWN is a drawing of the proposed Rainbow Bridge to replace the old Falls View Bridge or "Honeymoon" Bridge across the Niagara River, which was destroyed by ice in January, 1938. The new structure would be built about 350 ft. north of the site of the old crossing. Total length of the bridge would be about 1450 ft. to include a 950-ft. steel arch span. The width would be 58 ft. overall with two 22-ft. roadways separated by a 4-ft. mall plus a 10 ft. sidewalk on the upstream side.

The center of the pins for the hinges at the abutments are 55 ft. above low water (El. 337 above sea level) or about 29 ft. above pin centers on the old Falls View Bridge.

When bids were opened Mar. 19 for the superstructure, the Bethlehem Steel Co. bids of $1,451,000 for an arch span with concrete approaches (as shown above) and $1,697,000 for an arch span with steel approaches were low. The only other bidder was the American Bridge Co., which bid $1,466,000 and $1,754,000. If the plan calling for concrete approaches is adopted, the bids offered on Mar. 12 for the approach work must be considered. At that time the McLain Construction Co., Buffalo, submitted a low bid for the American approach, bidding $128,000, and the Cameron & Thin Co., Welland, Ont., for the Canadian approach, bidding $107,000.

Plans for the Rainbow Bridge have been prepared by Edward P. Lupfer Engineering Co., Buffalo, and Waddell and Hardesty, New York City. Aymar Embury, New York City, is the architect. The work is being done for the Niagara Falls Bridge Commission, an international body.

## Congress May Revise Boulder Power Rates

### Los Angeles and others would get one instead of 1.65 mill rate

A new bill to revise the financial arrangements for the sale of power from Boulder Dam has been introduced in Congress by Representative James G. Scrugham of Nevada; Scrugham introduced a similar bill last year but it was withdrawn because the interested parties failed to reach agreement.

As introduced, the bill gives Los Angeles and the other power users lower rates for power. The lower basin states, Arizona and Nevada, each get $900,000 right away and $300,000 a year from then on, though losing the future possibility of a larger sum. The upper basin states get $500,000 a year for the Colorado River Development Fund, again at the sacrifice of larger sums in the future. And the government gets closer control over the generating plant, now operated under lease by the power users.

Power rates at present are set to conform to rates prevailing in the load centers. Out of the proceeds is met, first, cost of operation and maintenance, second, amortization at 4 per cent over fifty years of the $125,000,000 advanced by the Treasury to the Colorado River project. Anything left over is to be distributed among the downstream states and a fund for development of the upper river. Nothing has yet been left over, but at the present 1.65-mill rate for power considerable sums will be left over in future.

### *A rate of one mill per kw.h*

The proposed bill would reverse this procedure and require that power rates be set at a level which will cover operation and maintenance, payment of $600,000 to the downstream states and $500,000 to the development fund, and amortization. This last would be substantially reduced by changing the interest rate to 3 per cent and deferring repayment of the $25,000,000 allocated to flood control for fifty years, no interest being charged meanwhile.

It is believed that on this basis the power rate would be in the neighborhood of 1 mill.

The present contracts under which the power users operate the generating plant would be cancelled and a new contract drawn by which the users would operate the plant as agents of the Secretary of the Interior—giving him closer control. It would be possible, under the bill, for the secretary to operate the plant himself, but the power

*(Continued on p. 56)*

## Panama Locks

(Continued from p. 53)

—each about half this years amounts—and dropped a budgeted $15,00,000 to start the new locks at Panama. Last week a subcommittee of the Senate appropriations committee recommended that these amounts be increased to $50,000,000 and $100,000,000 respectively and that the money for the Panama locks be restored. An additional $2,400,000 for additions to the power plant at Bonneville was also recommended.

Procedure on navigation and flood control projects is for Congress, at irregular intervals, to authorize a large number of projects. Each year, as money is appropriated, the chief of engineers selects from the authorized projects those he considers most urgent and spends the available money on them.

River and harbor projects which have been authorized and not built now amount to about $210,000,000, and outstanding flood control authorizations are $440,000,000. On the ground that these authorizations are many times the annual appropriations, the President has expressed on several occasions his opposition to any new authorizations and has threatened, by implication, to veto any authorization bill.

There is in Congress, however, considerable support for new authorizations, and the Corps of Engineers is known to want additional projects. Proponents point out that of the river and harbor authorizations about $50,000,000 is for projects which are undesirable and will never be carried out. Of the remaining $160,000,000 four large projects (the New York and New Jersey channels, and the Delaware, Mississippi, and Missouri rivers) take up $88,650,000. These projects will extend over many years, leaving only about $61,000,000 from which to select other projects.

The House last year passed a bill authorizing $84,000,000 in new projects. The Senate commerce committee last June reported a version authorizing $407,000,000, but this aroused so much opposition that it was sent back to committee. Last week the committee reported out a new bill authorizing $231,000,000 in new projects.

A bill providing additional flood control authorizations is now before the House committee on flood control.

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## Boulder Power Rates

(Continued from p. 55)

users seem confident this will not be done.

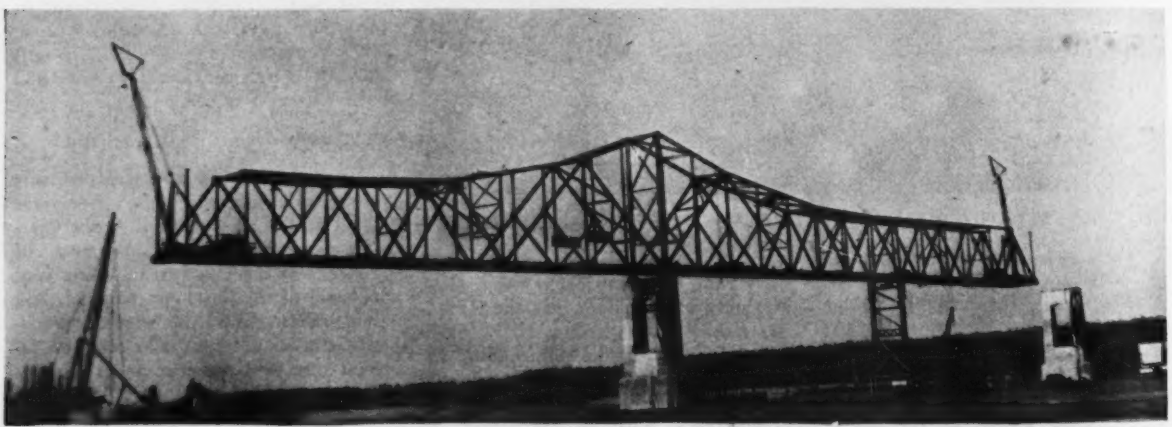
Possibility that the state or local governments might tax the power operations is eliminated by a clause stating that the payments to Colorado and Nevada are in lieu of taxes and that any taxes levied will be deducted from the payments.

## North Carolina Adds $5,000,000 to Road Funds

Gov. Hoey of North Carolina on April 4 allocated $5,000,000 from the state highway fund surplus for improvements to primary and secondary state roads. Of the amount $500,000 will be spent for bridges, $2,250,000 for improving secondary roads, and $2,250,000 for "standardizing" primary roads by widening, resurfacing, and new alignment. The state highway and public works commission has requested an additional allotment of $500,000 for the purchase of equipment to do the work.

A portion of the $500,000 for bridges will go to the secondary roads, with this work done by state highway crews but most of the other work will be let to private contractors, according to opinion from an authoritative source.

The allocation brings to $9,000,000 the total of state funds set aside during the 1939-40 fiscal year for highway improvements, Gov. Hoey on Sept. 29 having set aside $2,000,000 of the highway surplus for road improvements and on Mar. 27 a like amount. Together with $16,525,000 appropriated by the North Carolina legislature, $2,000,000 provided by the WPA and $3,000,000 in federal road funds, the $9,000,000 makes a grand total of $30,425,000 for road work in North Carolina during the fiscal year.



American Bridge Photo

**STEEL ERECTION FOR GREENVILLE, MISS. SPAN 50 PER CENT COMPLETE**

ERECTION of the superstructure for the $4,500,000 bridge being built across the Mississippi River at Greenville, Miss., had been more than half completed by the end of March under the direction of D. N. Garner, field engineer for the American Bridge Co., Pittsburgh. The cantilever structure has a main span of 840 ft. and two 640 ft. anchor spans; one anchor span is about completed, as shown in the view above, while the main span is cantilevered to about the center of the channel.

The river crossing proper is being constructed for the city of Greenville with $2,000,000 PWA grant, and a $2,200,000 RFC loan. The Massman Construction Co., Kansas City, represented on the job by Oscar H. Zimmerman, built the four river piers. L. D. Brown is representing Ash-Howard-Needles & Tammen, Kansas City, Mo., consulting engineers for the project, Charles A. Branch the PWA, as chief resident engineer inspector, and H. M. Gallagher the RFC.

The highway approach at the east end is being built by the Mississippi State Highway Department, R. A. Harris chief engineer; and the west approach by the Arkansas State Highway Department, W. W. Zass, chief engineer.

The work is scheduled for completion in June.

## *Suspended Quebec Engineer Fined for Continued Work*

The Corporation of Professional Engineers of Quebec has taken disciplinary action against W. N. Cann of Lenoxville, for exercising his profession in contravention of the corporation's regulations. Cann was fined $200 and costs because he made a waterworks improvement report for the town of Lennoxville and signed his name with the designation C. E., although he had been suspended from membership for non-payment of dues.

## *Court Rules Des Moines Exceeds Debt Limit*

A new classification of bonds to be used in calculating legal debt limit places Des Moines in the position of having exceeded its permissible indebtedness. A recent state supreme court ruling changed the classification. The immediate effect of the ruling will be the shutting down of all WPA projects in the city, as the city's share of WPA expense has been financed by city bonds. The city's permissable debt limit is now $8,290,000.

*A. L. Dementi Photo*

**NEW $2,100,000 HOSPITAL FOR VIRGINIA MEDICAL COLLEGE**

FOR THE Medical College of Virginia, a state institution at Richmond, a $2,100,000 hospital is nearing completion. The building, eighteen stories plus two basements, is of steel construction and will provide 281,000 sq. ft. of floor space at a cost of about $2,100,000 without equipment.

All floors in the building are to be winter air-conditioned and two floors summer air-conditioned. Later, when funds are made available, the building will be summer conditioned throughout.

G. A. Peple, Jr., Richmond, is the consulting engineer for the work; Baskervill & Son, Richmond, architects; J. Slotnik Co., Boston, the general contractor; N. W. Martin and Brother, Richmond, the heating and plumbing contractor, and F. E. Robinson & Co., Charlotte, N. C., the electrical contractor.

# WASHINGTON HIGHLIGHTS

*Special reports by Paul Wooton*

ADVOCATES of an extra half billion for WPA are afraid of a move to shift the money to PWA. An attempt on these lines was made last year by Rep. Starnes. They look for a compromise to emerge in the Senate in the form of a combined relief and public works bill providing for joint PWA-WPA projects, perhaps with WPA supplying the unskilled labor. Administrative groundwork for such a plan was laid last July when the President put the two agencies under one roof.

EXTENSION of the municipal bankruptcy act for two years from next June 30 is proposed in a bill placed on the House Calendar by its judiciary committee. The measure is expanded to include counties, as well as municipalities and taxing districts. But the House Committee excluded a proposal (once favored by the Senate) which would liberalize conditions under which bondholders would be considered to have assented to bankruptcy. The bill carries a prohibition against fiscal agents being both paid by the petitioner and profiting through exchange of bonds.

The investigation of technology being started this week by the Senate's Temporary National Economic Committee (*alias* TNEC, *alias* Monopoly Committee) may not seem to have much to do with public works, but in the minds of many government economists there is an intimate connection. Subject under investigation is whether technical improvements reduce opportunity for employment; TNEC will try to show that where, through monopolistic controls, economies are used to increase profits employment is reduced, but when savings are passed on in lower prices or higher wages employment is increased. In so far as the investigation reveals that there is a net reduction in employment opportunities, these economists believe, governmental agencies will have to take up the slack through public works construction program of suitable size.

A special master has been appointed by the U. S. Supreme Court to determine whether Chicago is justified in its plea to divert more than the 1,500 sec.-ft. from Lake Michigan which is now permitted by the court. Monte M. Lemann, New Orleans lawyer, is the special master.

# OBITUARY

FRANKLIN MARSH, former city engineer at Rahway, N. J., died in that city April 4 at the age of 84. Following his graduation from Rutgers University, Marsh taught at that school for some time. With Leonor F. Loree, former president of the Delaware & Hudson R.R., Marsh supervised construction of the Mexican National Railway in 1881-82.

BENJAMIN LOXTERMAN, 57, vice president and director of Blaw-Knox Co., died March 28 in Pittsburgh. Loxterman had been connected with Blaw-Knox since its formation 34 years ago, joining the firm as a draftsman in 1906 soon to be placed in charge of design and fabrication of steel forms. He was later made manager of service, next sales manager of the Blaw-Knox Division, and in 1934 director and vice president.

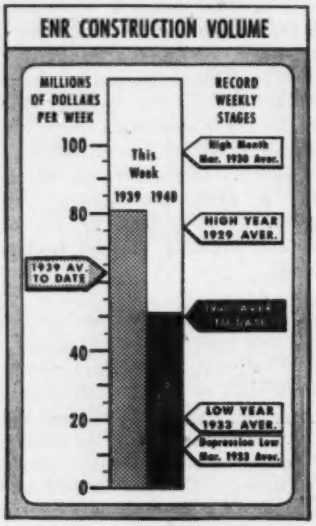
WILLIAM R. SMITH, president and general manager of the Lane Construction Corp., Meriden, Conn., and president of the American Road Builders Association in 1931, died in that city

WM. R. SMITH

April 5 at the age of 72. Smith was born at North Haven, Conn., Oct. 17, 1867. In 1893 he went to Meriden and two years later became associated with the late John S. Lane, founder of the Lane companies, in the crushed stone business. In 1902 when the Lane Corporation was organized, Smith was made general manager and since 1913 had served as president of the corporation.

# CONTRACTS AND CAPITAL

PRIVATE ENGINEERING construction awards for the week, $23,376,000, top the total for a week ago by 4 per cent, and are 12 per cent higher than the volume reported for the corresponding 1939 week. Public construction for the week, however, is 17 and 54 per cent lower, respectively, than last week and last year, and is responsible for the decrease reported in total construction. The week's total, $50,890,000, is 9 per cent lower than in the preceding week, and 37 per cent lower than in the 1939 week.




Private awards for the year to date total $261,714,000, an increase of 8½ per cent over the 15-week period last year. The total volume of engineering construction awards, $749,468,000, is 20 per cent lower than for the 15 weeks in 1939.

Six large commercial building projects in five states totalling $5,500,000 are largely responsible for bringing this class of construction to its highest level of the year. Public buildings and unclassified construction also register gains over last week. Comparisons with the 1939 week reveal gains in waterworks, industrial buildings, earthwork and drainage, and unclassified construction.

New capital for construction purposes for the week totals $10,302,000, an increase of 82 per cent over the week last year. The current week's financing is made up of $7,896,000 in corporate security issues, $2,356,000 in state and municipal bonds, and $50,000 in RFC loans for public improvements.

New construction financing for the year to date, $333,421,000, is 39 per cent below the $548,211,000 reported for the 15-week period last year.

(*Weekly table on page 51*)

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN MARCH, 1940

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

| | | | | | | | United States | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Three Months | | |
| **Public Works** | **New England** | **Middle Atlantic** | **South** | **Mid West** | **West of Mississippi** | **Far West** | **March 1940** | **1940** | **1939** | **Canada** |
| Waterworks | 354 | 1,614 | 984 | 4,537 | 1,421 | 442 | 9,353 | 19,947 | 79,833 | 74 |
| Sewerage | 33 | 1,141 | 353 | 1,686 | 873 | 9 | 4,095 | 23,628 | 55,009 | 110 |
| Bridges, public | 814 | 3,906 | 1,031 | 1,261 | 670 | 344 | 8,026 | 30,412 | 46,653 | 283 |
| Earthwork and waterways | 56 | 2,417 | 1,029 | 826 | 4,470 | 1,388 | 10,186 | 46,818 | 42,561 | 71 |
| Streets and roads | 5,168 | 13,090 | 14,014 | 10,145 | 12,981 | 3,540 | 58,938 | 169,336 | 141,145 | 459 |
| Buildings, public | 1,997 | 3,447 | 7,140 | 917 | 2,798 | 3,007 | 19,306 | 97,692 | 181,029 | 1,342 |
| Unclassified, public | 1,964 | 2,045 | 1,229 | 731 | 2,069 | 2,343 | 10,381 | 39,082 | 46,159 | 575 |
| **Total public** | **10,386** | **27,660** | **25,780** | **20,103** | **25,282** | **11,073** | **120,284** | **426,915** | **592,389** | **2,914** |
| Federal government (included in above classifications) | 2,442 | 2,660 | 5,141 | 1,936 | 4,282 | 4,325 | 20,786 | 76,586 | 61,421 | ..... |
| **Private** | | | | | | | | | | |
| Bridges, private | ..... | 35 | ..... | ..... | 250 | ..... | 285 | 285 | 2,065 | ..... |
| Buildings, industrial | 702 | 2,765 | 2,945 | 3,518 | 9,017 | 1,964 | 20,911 | 93,190 | 47,339 | 362 |
| Buildings, commercial | 2,250 | 15,814 | 5,103 | 3,500 | 2,625 | 3,101 | 32,393 | 91,024 | 100,008 | 2,250 |
| Unclassified, private | ..... | 1,183 | 2,380 | 475 | 893 | 1,032 | 5,963 | 31,327 | 59,301 | 448 |
| **Total private** | **2,952** | **19,797** | **10,428** | **7,493** | **12,785** | **6,097** | **59,552** | **215,826** | **208,713** | **3,060** |
| **Total Engineering Construction:** | | | | | | | | | | |
| **March, 1940 (4 weeks)** | **13,338** | **47,457** | **36,208** | **27,596** | **38,067** | **17,170** | **179,836** | ..... | ..... | **5,974** |
| February, 1940 (5 weeks) | 8,964 | 54,235 | 53,445 | 58,334 | 47,171 | 48,779 | 270,928 | ..... | ..... | 9,729 |
| March, 1939 (5 weeks) | 19,812 | 109,429 | 38,294 | 45,020 | 49,722 | 23,289 | 285,566 | ..... | ..... | 7,344 |
| Three Months — 1940 | 27,725 | 163,778 | 120,749 | 112,646 | 129,408 | 88,435 | ..... | 642,741 | ..... | 19,814 |
| Three Months — 1939 | 51,900 | 263,302 | 114,309 | 136,817 | 154,352 | 80,422 | ..... | ..... | 801,102 | 16,254 |

RICHARD E. TURNER, 55, president of John J. Turner & Sons Construction Co., Amsterdam, N. Y., died late in March while returning from a vacation in Panama. Turner was a graduate of Rensselaer Polytechnic Institute with the class of 1905.

A. T. RITCHIE, 43, construction engineer with the federal government, died last week in Pittsburgh. For the last few years Ritchie had been stationed in Washington, D. C., being transferred to the Pittsburgh office at the beginning of this year. He was a graduate of Rochester University.

EDWIN OWEN, 79, until 1927 president and since then chairman of the board of the Owen-Ames-Kimball Co., Grand Rapids, Mich., died April 4 in Grand Rapids. Owen early in life was associated with James J. Hill on the Great Northern Ry. west of Minneapolis.

GREGOR LENOX MATTICE, consulting engineer and chief inspector of ammunition for the Canadian government during the World War, died April 5 in Montreal, Que., at the age of 68. Following his graduation from Royal Military College at Kingston, Mattice engaged in railway construction work for many years, being with the National Transcontinental Railway for eight years—including two years as district engineer at Cochrane, Ont. He joined Lockwood, Greene & Co. in 1920 to serve as Canadian manager from 1923 to 1925.

SHIRLEY BARR, 61, former chief engineer of the Canada Cement Co., died March 31 in Montreal, Que. Barr early in life worked with the Link-Belt Co., Chicago, going to Canada in 1905 to join the Exshaw Cement Co., Exshaw, Alberta. Later he worked with the International Cement Co., before becoming chief engineer of the Canada Cement Co.

WILLIAM W. PINKERTON, retired civil engineer formerly with the Pennsylvania R.R., died April 2 at St. Davids, Pa., at the age of 69. Pinkerton, a graduate of the University of Pennsylvania in 1891, first worked for the Pennsylvania in 1887.

JAMES A. S. REDFIELD, 64, who retired several years ago as assistant chief engineer in charge of maintenance for the Chicago & North Western Railroad in Chicago, died this week in Fort Lauderdale, Fla. For a time Redfield served as assistant engineer of maintenance for the railroad at Omaha.

W. ROY ADAMS, vice president in charge of sales for J. D. Adams Co., Indianapolis, died April 6 in San Francisco.

**LONG LAMINATED TIMBER CANTILEVER BEING TESTED**

WHEN THIS laminated timber cantilever beam 110-ft. long, with two central supports 20 ft. apart and two 45-ft. cantilever overhangs was tested at Seattle, Wash., with a total load of 27,000 lb. to simulate a uniform roof load of 60 lb. per sq.ft., no slipping nor distortion along the glued joints was observed. The beam, made up of No. 1 2x10 in. planks with a maximum length of 20 ft. in any single piece, is 10 in. wide and 52 in. deep at the center; its total lumber content is 3,780 fbm and its weight about 8,800 lb. during fabrication only sufficient nails were used to hold the planks in place while the 118 lb. of glue used in holding the laminations together was setting.

Advantages of this type of construction claimed are: that it makes possible the use of timber in standard stock sizes; that checking, common in large timbers, is eliminated; and that defects in individual pieces of lumber do not affect the strength.

The beam was built and tested by the Speedwall Co., Seattle, Wash., using Laux self-bonding casein glue.

## *Alaskan Highway Report Prepared*

**President may get preliminary report late this week on the $20,000,000 job**

A preliminary report on the $20,000,000 Alaskan Highway from Seattle to Fairbanks will be submitted to the President late this week or early next, Rep. Warren Magnuson, chairman of the Alaskan Highway Commission has told an *ENR* reporter. The report will stress the feasibility of the project, the revenues to be expected from tourist traffic, and the military value of a land connection with Alaska. It will recommend that the life of the committee be extended beyond this June and that about $6,000 be appropriated to permit the territorial highway department to make surveys of two alternative routes. The Canadian government has already made extensive surveys of portions of the route lying in its territory.

Preliminary investigations by the commission indicate that a 24-ft. gravel road could be built along an inside route for about $10,000 per mile.

Of the 2,000-mile length of the highway, about 1,500 miles lie in Canadian territory, and there is therefore little likelihood that the project will be carried out while the war lasts—unless international developments should increase its military importance. The Canadian Commission, of which Charles Stewart is head, feels, however, that the project will be well adapted to employing demobilized troops at war end and is anxious to have the project set up in advance.

If Congress accepts the present recommendations of the commission, and surveys this summer bear out the findings, it is probable that a report will be submitted in the fall urging detailed location surveys.

• • •

## *Second Delaware Aqueduct Section Holed Through*

Indicative of the progress on the Delaware Aqueduct to bring water to New York City from the upper Delaware River watershed was the "holing through" last week of a second section of the aqueduct. Contractors Seaboard Construction Corp., Jim McAtee, superintendent, driving north 8,000 ft. from Shaft 13 and Utah Construction Co., Benj. Arp., superintendent, working south 9,000 ft. from Shaft 12 found good rock and made excellent progress. Tunnel excavation now is 60 per cent near completion.

# COMMENT AND DISCUSSION

*Readers' opinions on matters that concern the engineer*

## Talbot Spiral?

Sir: The comments of A. Tiggelbeck, on spiral curves for highways (*ENR*, Jan. 4, 1940, p. 32) repeat five times the words "Talbot Railway Spiral" or "Talbot Spiral" and credit the origin of this spiral as applied to railway alignment to Prof. A. N. Talbot. The fact is that this curve was presented to the public and quite fully treated by Ellis Holbrook in the Railway Gazette in 1886, and a comparison of Mr. Holbrook's original presentation with Prof. Talbot's book will be of interest to anyone wishing to be accurate in giving credit for engineering developments.

RALPH W. STEWART
*Los Angeles, Calif.*

## Famous Engineers

Sir: With respect to the question as to why there are so few famous engineers today: Since the tremendous projects of the last few years are incontestible evidence that the men who directed them are technically of as high an order as those who have gone before, the problem of fame must lie (with an important exception) outside the intrinsic quality of the men and in the mechanism and attitude of present society.

Complex industrialization reaching into every corner of our nation has made a commonplace of engineering marvels. Until catastrophe occurs—a flood, an earthquake, a conflagration—the public forgets the physical mechanism of a complex society and those who have provided it. Familiarity has bred, if not contempt, at least neglect.

Engineers labor under another serious handicap, the characteristic of our developed society which emphasizes the distributive and the financial element rather than the productive. This trend is accelerated because the work of the engineer is not often directly and quickly profitable. Usually it has its diffused effect over long periods. This requires a secondary quality of reasoning mind which the public, unaided, rarely exhibits.

The public reacts strongly to the visual and the spectacular. The engineer's work is done, largely removed from public contact and sight. To an increasing extent, furthermore, engineers have become employees of great corporations and have in this process lost much of their identity as individuals.

Employers of engineers in general have not been eager to ascribe credit to their engineering staffs. Engineers themselves, of course, are partly responsible for their predicament. While operating his art in the hurly-burly of a highly commercialized society, the engineer acts as though he were a pure, abstract scientist. This error springs from a rooted misconception about the real work of the profession. Broadly speaking, the task of the engineer is to guide and advise finance, plan operations, organize men, material, equipment, power and skill into finished projects controlled by basic economic factors. There is, accordingly, no lowering of dignity in public presentation of the work, in participating in commercial affairs to help steer it, in exposition before civic bodies, even in political organization for the good ends which are sought.

A broader culture is now required of the engineer. Too narrow a specialism resulting in inability to meet necessary elements of society on equal terms means that the engineer is often considered a mechanism, a tool, rather than a man.

These ideas are not new. But to make them effective, we must bell the cat which lies athwart our path. We must regain touch with the public and build up the sputtering flame of its awareness of our highly constructive profession. We must penetrate the barrier between us and the people by reawakening their interest and deepening their realization of what engineering has brought to our daily lives and what it can do in the future for our nation. Interesting newspaper columns could be developed, fascinating films created, newsreels focused upon outstanding works in construction and operation. Gripping radio broadcasts can be made.

Like removing debris and tarnish from some great masterwork, obscured, great men of the profession will stand revealed again and the glow of fame will supplant the dull haze of neglect. This is a worthy task for the profession, its national societies and their organs to undertake.

ZARA WITKIN
*Civil Engineer*
*Los Angeles, Calif.*

## Engineering Fame

Sir: "Why so few famous engineers today?" you ask (*ENR*, Aug. 17, 1939, p. 266 and Feb. 1, 1940, p. 167). There are many engineers who have attained high rank in the profession, but due to the lack of other qualifications have not attained the position where society has acclaimed them famous. Why? you ask.

That is an ever-recurring question, not only in the engineering profession but in all avenues of life. Fame that is enduring is only for those who use their superior ability and accomplishments for the benefit of mankind; benefits that are curative, preventive or creative. Engineers are taught to think clearly and accurately. This ability is vital in order successfully to study and solve the problems of life. To effectuate it, however, and translate it into the good of humanity requires the ability and desire to transmit the results to others.

What the engineer as a class lacks is not so much clear thinking, but the technique of self-expression which is persuasive enough to win approval and support from others. When our engineering schools and colleges include in their curricula adequate courses in humanics, ideals of service, human relationships, the art and technique of salesmanship, and the rudiments of diplomacy, then their highly trained graduates will be better fitted to effectually carry out their discoveries for the advancement of society and thus become worthy to be classed as famous.

One reason I feel Mr. Hoover did not succeed any better as president is that from all counts he lacked the art of persuasion. I understand that from the time he graduated from Stanford till he assumed the office of president, he had men working *under* him; and consequently never had to entreat or plead, to any great extent

at least, to accomplish his way. So whatever his past training and ideals were, their persuasive tendencies atrophied and he was ill fitted to cope and work with a mass of people whose thinking was cloudy and over whom he had no control. If he had had one tenth that ability of our present incumbent I feel he would still be our leader and we would have avoided much of our past, present and future troubles.

JOHN F. MILLER
*Consulting Engineer*
*New York City*

## Constant Angle Dam

Sir: Reference is made to p. 112 of your issue of Feb. 15, 1940, wherein a paragraph is written regarding the California debris dams. It is stated therein that "The Narrows Dam on the Yuba River, a 237-foot arched gravity section, was started in February, 1939, and scheduled for completion in 1940."

For your information it is desired to point out that the Narrows Dam is not an arched gravity section but a constant angle arch dam.

L. B. CHAMBERS
*Colonel, Corps of Engineers*
*District Engineer*
*Sacramento, Calif.*

## Valuable Dredging Data

Sir: All engineers and other construction men who are interested in the performance of hydraulic dredges should be grateful for the article "More Profit from Suction Dredges" by R. L. Vaughn in the Feb. 29 issue, p. 52. The data given regarding critical velocities in discharge lines and of the relation between velocity and output should be of value as reference material, but of even greater value is the practical suggestion of the various factors which have a marked effect on the economical operation of dredges working in varying materials. While it is generally recognized by dredge men that the operation of a suction dredge in a manner best suited to a given set of conditions is still more or less of a cut and try proposition, the suggestions contained in the article under discussion should be of material aid in reducing the time and effort required for experimentation.

The only criticism which has occurred to the writer concerning Mr. Vaughn's article is that he did not include a discussion of the design and operation of cutters for suction dredges. While some other type of equipment is usually selected if considerable quantities of rock, boulders and stumps are to be handled, many materials which would otherwise present serious difficulties can be handled successfully by a hydraulic dredge if it is equipped with the proper device for dislodging the material and reducing it to a condition suitable for passage through the pipes and pump. In illustration, soft river mud requires the minimum of agitation (or perhaps none at all) to render it suitable for picking up by the suction line, while many tenacious clays call for a sturdy cutter, operating at comparatively low speed but with ample power behind it. It has been the writer's observation that too many dredging contractors, especially those owning only one or two dredges, attempt to work in varying materials without giving sufficient attention to type of cutter used and the method of its operation. A discussion of these points by a competent writer would form a valuable supplement to the material presented by Mr. Vaughn.

ARTHUR M. SHAW
*Consulting Engineer,*
*New Orleans, La.*

## Brick Paving

Sir: I have read with great interest an article entitled "Machine-Refined Brick Paving" in *ENR*, Jan. 4, 1940, by George J. Thormyer, engineer for Ohio Department of Highways. The newer machine methods of constructing brick pavement offer greater possibilities in the construction of a monolithic brick pavement with the added possibility of securing a more efficient and economical type of brick pavement.

In this connection, I recall the construction of certain monolithic brick pavements in Illinois and the effort to develop the favorable qualities of a monolithic type brick pavement. Possibly some of the older engineers will recall that Mr. W. T. Blackburn of the National Paving Brick Association sponsored monolithic brick pavement in Illinois some twenty-five years ago and several sections of this type pavement were constructed more or less as an experiment. In general, these pavements presented a rather uneven surface and due to various construction difficulties never came into general use. The newer machine-refined brick paving, as proposed by Mr. Thormyer, apparently offers a solution to some of the difficulties encountered in the early experiments here in Illinois.

Recalling these early experiments, I believe there might be some present interest in a review of an article by the writer entitled "Brick Pavement Design," published in *Engineering and Contracting Magazine* under date of July 7, 1915. In that article, I undertook to set out in detail various fundamental principles involved in the design and construction of a brick pavement and arrived at the conclusion that a monolithic brick pavement was the most economical and efficient type where a brick wearing surface was contemplated. I am very pleased to see these more recent investigations of the monolithic type brick pavement and have great confidence that this type pavement offers many advantages over the design of brick pavements in general use.

WILLIS D. P. WARREN
*Consulting Engineer*
*Decatur, Ill.*

Editor's Note: We quote from Mr. Warren's original article, "Brick Pavement Design," written twenty-five years ago.

"The method proposed is to use a reinforced concrete foundation with a 1:4 mix 2 in. thick; to construct the same with a fairly soft plastic mixture of cement and aggregate, graded from fine to ¼ in. or even ¾ in., to lay the brick directly on this foundation, it serving in its plastic state as a uniform support to the wearing plate (brick) and in its hardened state as a foundation to the wearing plate."

Mr. Warren further recommended: (1) 3-in. thickness of brick; (2) spreading the concrete with a steel faced templet; (3) flat sheets of reinforcement laid on top of the 2 in. of concrete; (4) laying the brick immediately on the plastic concrete and rolling with a heavy hand roller; and (5) brooming in grout. He claimed the concrete would be stronger due to the compaction and rolling and expected to get full monolithic beam action from the thin slab and brick top with the reinforcing near the neutral axis. Naturally the cost would be lower due to savings in material and the fact that all work was done at one time by one gang.

# ENGINEERING NEWS-RECORD

Volume 124, Number 15

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*April 14, 1940*


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EMPHASIZING INNOVATIONS in water supply, a major part of this issue is devoted to novel developments in waterworks design, construction and operation. Interesting and perhaps significant is the fact that the examples of new practice originate from points that stretch from coast to coast. And in the group of articles beginning on page 81, the range of subject matter goes from aqueduct planning on the mammoth water system for New York to the practical application of research findings in the control of microscopic organisms in reservoirs. The water supply engineer is by training, experience and necessity an individual of broad interests and knowledge. That he is utilizing his talents effectively to assure the rest of us adequate supplies of ever purer, more potable water is attested to by the developments that are recorded in this issue.

## *Overcoming Difficulties*

SPEED, CONVENIENCE AND SAFETY for the traveling public are now the factors that fix the design of highway structures. If the roadway centerline makes a sharp angle with bents or piers, which must be placed parallel with a stream, a railroad or an underpassing roadway, the designer must make the best of it. However, such difficulties of design as may result are not to be confused with disadvantages. On the contrary, they whet the imagination, give ingenuity a chance, and lift the spirit when they are overcome. For example, the designer in the California highway department who conceived and executed the skew framing system described in the March 28 issue, whereby the span of the girders was reduced from 84 to 34 ft. by the expedient of placing the girders normal to the bents instead of parallel to the roadway centerline, must feel pretty good about it. Not only did he produce an interesting and economical design, but the necessary mental exercise and the feeling of accomplishment that he enjoyed were undoubtedly of real personal benefit.

## *Still Using Scrapers*

THE CONSTRUCTION of Hansen Dam, described in this issue, engages one's thought on the remarkable record of that age-old earthmoving tool, the scraper, in American construction. Operated by hand and horse drawn, it competed with the dump cart in early railway and canal construction. As earthmoving moved west onto the plains the drag scraper took on wheels and in the far west it appeared as the famous Fresno. The advent of the power shovel as a major earthmoving tool never eliminated the scraper even in heavy excavation when, on draglines and slacklines, it built Mississippi levees and irrigation canals. Then in the last half dozen years the old wheel scraper took on size and pneumatic tires; it became a 10, 12 and 20-yard excavating, spreading and carrying scraper. Finally, speed of travel has been added by improved hauling units, and the remarkable Hansen Dam scrapers are setting records of fast and cheap embankment construction. No tool is a better example of evolution through equipment engineering.

## *Dollars from the Sun*

WHEN SUNSPOT ACTIVITY upsets the communication facilities of half the world as it did a few weeks ago, we have a spectacular demonstration of the influence of solar radiations. Less dramatic but equally potent is the influence of solar radiation on algae, those tiny organisms that inhabit reservoirs and impart tastes and odors which are the despair of waterworks operators. It has been generally assumed that alga growth was a function of water temperature, but patient research by R. F. Goudey, engineer of the Los Angeles water bureau, suggests otherwise. In an article on page 95 he tells the story of how he found a correlation between solar ultra-violet rays and alga activity; as a result, Los Angeles is saving $5,000 a year in chemical control treatments and the algae are checked before they have a chance to begin their work. Goudey's significant discovery and its translation into dollar savings should be of interest to every waterworks man.

## *More Waterway Waste*

CONGRESS is traditionally free-handed with the taxpayer's money when it comes to waterway development, although there is sad lack of proof that

more federal money to build more waterways is really needed. For many generations river and harbor bills have been the prime pork on which Congressmen exist, and accordingly it is no surprise to find that last week Congress went far beyond the budget allotments to these services. Probably Congressional liberality will not come to an end so long as the doctrine of free waterways gives encouragement to pressure groups.

## Pay for Engineers

LATE IN MARCH, Allen Richmond, one of the assistant secretaries of the American Society of Civil Engineers, handed to the highway commissioners of Arizona a proposed schedule of classifications and salaries for engineering positions in the highway department. Result of an urgent request from the Arizona Section of the Am. Soc. C. E. for aid in a bad personnel situation, the study marks an important step in the current attempts to develop better means for handling matters relating to the compensation of engineers.

The significance of the Arizona study goes far beyond that state because it is a step ahead in the development within our engineering organizations of means for dealing with matters of that kind. With the notable exception of the action of the American Association of Engineers in getting better pay for engineers in railroad service back in the World War days, engineers have had no recognized means for getting action on pay questions short of joining a trade union.

Nurtured by the depression there has been a growing demand, especially among the younger men, for more interest in their economic welfare on the part of the technical and professional societies. The unemployment work of the Founder Societies and the work done by the Am. Soc. C. E. in getting better pay for engineers employed by federal work-relief agencies were results of this demand. More recently, the Am. Soc. C. E. gave its approval to a schedule of pay for several classifications of engineering work. The Arizona highway report marks the final stage of the current development, the application of carefully developed schedules to a specific case.

What the Arizona highway commission will do with the salary report is not known at this writing. In any event it paves the way for similar reports in the future that should go far in convincing engineers that they do not need to resort to strike threats to gain consideration of their appeals for better pay.

## Help the Client

COMPETITIVE BIDDING for professional engagements has never succeeded in winning acceptance as a recognized method of conducting engineering practice. Nevertheless it persists, as indicated by recent cases in Tampa, Fla. and Flagstaff, Ariz., and the paradox of its persistence presents a serious problem to all concerned.

Long experience with competitive bidding has failed to develop it into a workable device. If anything it progresses from bad to worse. Current evidence of negative progress may be seen in the recent attempt of the city of Tampa to obtain extensive and responsible engineering services on the cuff—the engineer to receive no pay for his services except in the form of a future engagement that might be entered into under certain contingencies. Such cases, as well as the more common one of competition on fees, bring out clearly the risks to which competitive bidding exposes both the public and the engineer.

There is no need to enlarge on the risk to the engineering profession through progressive debasement of the quality of its service and piling up of unnecessary costs. The risk to the public is hardly less obvious. Buying services of unspecified kind and extent is hazardous and expensive no matter how low the price. In legal matters, public officials are conscious of these risks, and few cities would entrust an important bond or damage suit to a lawyer engaged through competitive bids. Yet when they undertake to build works costing millions, whose entire value depends on specialized skill, on resourcefulness and conscience in investigation and planning, they are willing to barter as though for a carload of coal.

To reform this condition is the profession's own job. It should be done, in the interest of the public even more than in the interest of engineers. But the problem is by no means the simple one of setting up a system of ethics and proceeding to enforce it.

It is necessary first of all to recognize that the evil grows out of the public official's lack of knowledge with respect to obtaining qualified engineering services. Providing this knowledge and thereby doing away with competitive bidding is not easy, in view of the range of conditions and area involved. But once the problem is clearly faced, engineering resourcefulness should discover a solution. To devise means by which those in need of engineering service may be supplied with the information required for well advised decisions cannot be an impossible task.

Butler Air Photo

FIG. 1. MAIN AVE. BRIDGE (IN FOREGROUND) PROVIDES A NEW CROSSING OF THE CUYAHOGA RIVER IN CLEVELAND.

# Lakefront Freeway Speeds Cleveland Traffic

***Contents in Brief*** *— For years out-of-town motorists have avoided Cleveland because of downtown traffic congestion. Now, the new Main Ave. Bridge and 6 miles of lakefront boulevard, with grade separations of bold engineering design, will provide for continuous flow of traffic through the city. The bridge and about 4 miles of the boulevard are already in service.*

FARSIGHTED REGIONAL PLANNING in Cleveland has resulted in the inauguration and partial completion of a plan to carry traffic along the Lake Erie waterfront from Gordon Park on the east to West Blvd. at Edgewater Park on a road free from the usual restrictions of cross traffic and bottlenecks. Known as the Lakefront Freeway, this road consists of broad multi-lane highways and a continuous cantilever truss viaduct over the downtown industrial area and the Cuyahoga River, known as the Main Ave. Bridge. Advantage is taken of a lakefront location to avoid cross traffic, but where it may occur, especially at entrances to lakefront recreational facilities, adequate provision has been made to carry it with structures utilizing the latest design advances in welding and rigid frames.

From the east, connecting with States Routes 2 and 283, four miles of new macadam road 50 ft. wide has been constructed as a WPA project sponsored by the City of Cleveland, from Gordon Park to East 9th St. From the terminus of this road a section known as the Lakefront Ramp is now under construction. This crosses the New York Central and Pennsylvania Railroad tracks at a skew of 57 deg. and a grade of 4.15 per cent on a three-line, four-span continuous steel girder. One of these spans is 270.8 ft. long, said by the engineers to be the longest plate girder span in North or South America. The girders are 12 ft. deep through the central portion, increasing in depth from a point 60 ft. from either end of the span to 15 ft. 8 in. at the piers. The bridge deck is carried on cross joints resting directly upon the three lines of girders and forming the top lateral system of the truss. Cross frames of the Vierendeel type are provided at about 18-ft. intervals. The roadway in this section consists of two 12-ft. traffic lanes and an escape walk in each direction separated by a raised center strip.

Connecting to the continuous girder section is a series of eight steel rigid frame structures 1,206 ft. long with the same roadway section carried on two lines of frames 35 ft. apart. This section is built on a 1,000-ft.-radius horizontal curve. Because of this curvature and a number of skew supports, spans for the two lines of frames vary from 13 to 122 ft., making design for secondary stresses and detailing very difficult.

### Westerly approach

The Lakefront Ramp and this rigid frame section constitute the easterly approach to the Main Ave. Bridge. On the west, equally elaborate approaches are provided, involving separated pavements with six

or eight 12-ft. traffic lanes, a large number of grade separations, a minimum number of points of entry, accelerating and decelerating lanes at entrances and exits, and auxiliary truck roads. Easy vertical and horizontal curves permit 1,000-ft. sight distances. The slab thickness is 8 in. with an 8-in. depth of curb to permit later surfacing if required. A 4-in. insulation course is used with adequate tile to insure a properly drained subgrade.

This westerly section will have four grade separation structures all designed for H-20 loading. Two of these are to accommodate traffic to the recreational facilities of the lakefront, with special provision for considerable pedestrian use. One is a reinforced concrete rigid frame of the barrel type with a clear span of 66 ft., longest in the area.

Another structure is of the steel beam and girder type notable in its provision for lateral expansion. This bridge is on a 54-deg. 33-min. skew so that the wide roadway requires an unusually great length measured parallel to the abutments. It is this length which makes provision for expansion desirable and introduces the unusual problem of providing for movement in two directions.

Longitudinal expansion is provided by means of rocker bearings at the ends of the 90-ft. outside girders and two sliding plate bearings for all longitudinal floorbeams bearing on the abutments. A steel grease box is framed around each of these plate bearings and filled with a suitable lubricant to prevent "freezing."

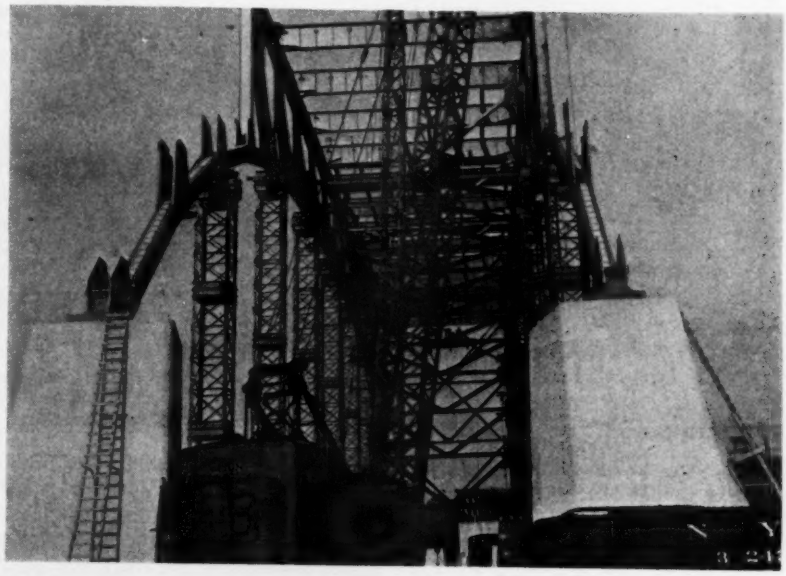


**Fig. 3.** Towers at alternate panel points support land spans during erection with long-boom crawler crane.

### Main Avenue Bridge

The principal structure of the Freeway is the Main Ave. high level bridge. Alignment of this structure was dictated by necessity for maintaining the existing Main Ave. swing bridge over the Cuyahoga River and by the desire to keep land condemnation costs in this area to a reasonable minimum. Two curves are necessary in the main spans of the bridge.

The general foundation material is a soft to medium hard clay soil to a depth of more than 150 ft. In some cases a wet sand overlies the clay. For these conditions, foundations partly on piles and partly on spread

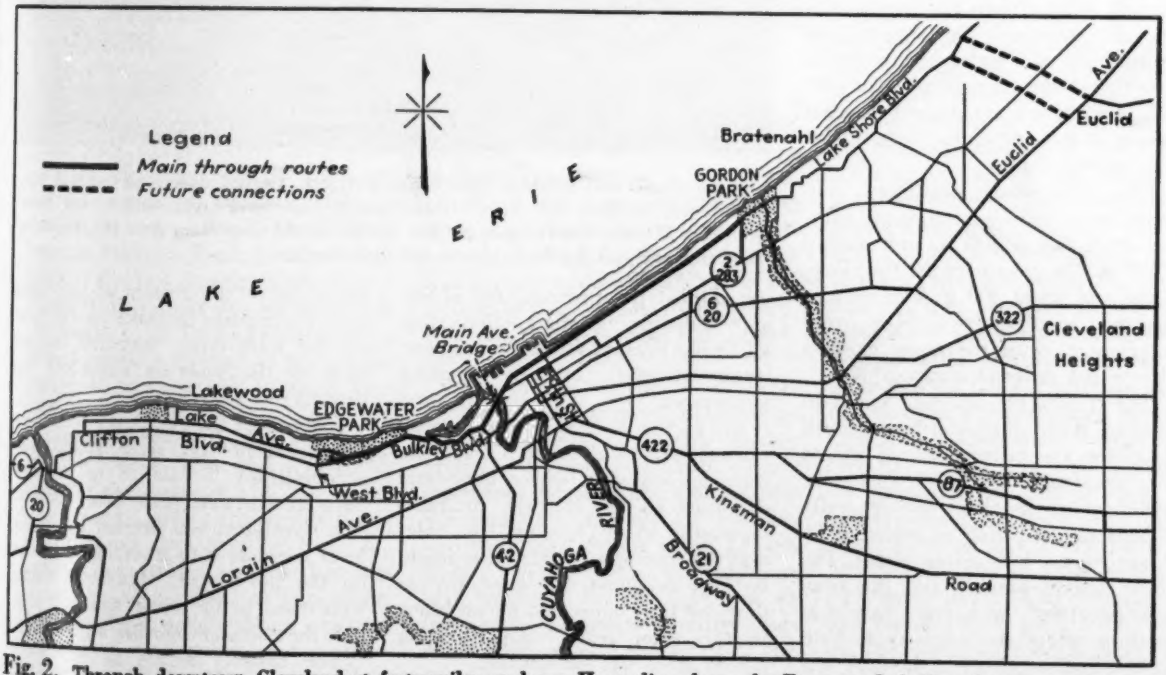



**Fig. 2.** Through downtown Cleveland at forty miles an hour. Heavy line shows the Freeway, dash lines future connection to principal highways.

Fig. 4. The 400-ft. span over the Cuyahoga River was erected by cantilevering, with derricks on the deck. Note old swing span, to be maintained for industrial area.

footings surrounded by deeply driven sheetpiling were chosen while a series of truss anchor spans with cantilever arms and short intermediate suspended spans was found to be most economical for the superstructure. This type of construction combines economy of continuous trusses with the possibilities of providing a pleasing outline for the structure and at the same time eliminates difficulties which might result from differential settlement of the various piers on clay soil. Simple span trusses were not considered because of the difficulty of combining good appearance with reasonable economy. The lower chords of the trusses are curved, giving the structure the architectural appearance of a series of arches. In order to produce a more pleasing outline, the trusses are made somewhat deeper at the piers than necessary for maximum economy.

The continuous cantilever construction consists of ten spans varying from 200 to 400 ft. and totaling 2,520 ft. The span over the Cuyahoga River was set at 400 ft. The remaining span lengths were fixed to avoid interference with the many existing streets and railroad tracks.

The trusses are designed for H-20 loading. Both upper and lower chord members are constructed of closed box sections. Verticals, diagonals, and bracing members are generally H-sections consisting of rolled wide-flange beams with cover plates. The lower lateral bracing and the sway bracing are of the K type. Except at sections where the roadway is built to fit a horizontal curve, the deck acts as the only upper lateral system. The use of this type of bracing and of box and H-section members eliminating all lacing bars, produced a clean-cut, sturdy structure of very pleasing appearance.

All of the steel is copper-bearing carbon, structural grade, except one truss of one span where horizontal curvature of the roadway produces unusually heavy loading. In order that the members of this truss might be kept to about the same size as those of the corresponding members in the other truss, copper-bearing silicon steel was substituted.

The bridge deck, a steel grid system 4¼ in. deep filled with concrete, carries two 34-ft. roadways for three-lane traffic in each direction, separated by a center strip 2 ft. wide and 1 ft. high. A 5-ft. sidewalk and railing on each side make a total width of 82 ft. for the superstructure.

The trusses rest on hollow reinforced concrete pier shafts extending to as much as 37 ft. above the footing. The pier shafts, except for the two river piers, are supported on closed-end fluted steel sheet piling driven from 50 to 60 ft. into the underlying clay soil and filled with concrete. The shafts of the two river piers rest on footing mats 93 ft. by 38 ft. by 5 ft.-6 in. thick about 24 ft. below ground level. The mats are surrounded by steel sheetpiling driven 20 ft. below the bottom of the mats and left in place to make lateral flow of the underlying material impossible if the river is deepened by dredging or scour.

Butler Air Photo

Fig. 5. Grade separations at west bridge entrance. Central depressed roadway carries two-way traffic to and from Detroit-Superior high level bridge and to and from downtown Cleveland. Side roads are for one-way traffic over Main Ave. Bridge while ramp and overpass between take trucks to city streets.

Erection of the cantilever truss sections, except the river span, was accomplished by use of tower supports at alternate truss panel points. The river span was erected by cantilever methods with traveling derricks on the top chord. Hydraulic jacks were used in the river span to provide the necessary closing adjustment.

The easterly access to the main structure is the arterial Lakefront

Ramp, described above, and two 34-ft.-wide three-lane ramps from the city streets to carry traffic on and off the bridge. The ramp pavement is placed on fill ground between concrete retaining walls. From this point to the continuous truss spans the roadway is carried on conventional steel column and girder supports except for a single simple truss span across several railroad tracks. For some distance the column and girder construction carries two decks, the lower providing access to the fifth floor of an adjacent warehouse building.

The westerly access to the bridge is complicated by the necessity of serving heavy city-bound traffic using the main approach roads but not desiring to cross the bridge and of accommodating trucks wishing to use the bridge but not permitted on the approach roads. This problem is solved by the three level crossing shown in Fig. 5. The lower level carries passenger car traffic between the approach roads and main traffic arteries on the west side of the river on two 24-ft. roadways. The second level provides a connection from adjacent city streets principally for truck traffic. The two upper level roadways carry traffic on and off the main structure on three-lane 34-ft. roadways.

The structure was financed in part by PWA funds made available in October of 1937. Actual construction started in May of 1938. The structure was opened to traffic in October of 1939, an unusual record of accomplishment in design and construction of such a bridge.

### Personnel

The engineers directly responsible for the design and construction of the bridge were: John O. McWilliams, county engineer; W. E. Blaser, county bridge engineer; Fred L. Plummer, chief designing engineer; and R. W. Deitrick, chief resident engineer. Wilbur J. Watson served as consulting engineer to the Board of County Commissioners until his death. Legal and financial aspects of the project were handled by Joseph F. Gorman, James S. Reynolds, and John F. Curry, county commissioners of Cuyahoga County.

The principal contracts for construction were executed by the following firms: Lombardo Bros. Construction Co. of Cleveland, river piers and parts of the east approach; Sam W. Emerson Co. of Cleveland, west approach and part of the east approach; A. J. Forschner Construction Co. of Chicago, principal land piers; R. C. Mahon Co. of Detroit, steel superstructure; and National Engineering & Contracting Co. of Cleveland, the east approach and the Lakefront Ramp.

# 65,000 Yards Daily at Hansen

***Contents in Brief—Compaction 95 per cent perfect was attained with a fleet of fifteen large carrying scrapers, working at record speed. Job equipment valued at $1,250,000 made it possible to place a 14,700,000-cu. yd. fill at bid prices averaging 20.7c. per cu. yd.***

NOTABLE SPEED in making a dry fill, experiment with novel equipment and a record for success at low unit prices mark the approach to completion of Hansen Dam, a 14,700,000-cu. yd. flood control structure on Tujunga Wash, a major tributary of the Los Angeles River. Easily the world's largest dry fill dam (100 ft. high, 9,500 ft. long), special interest has been focused on the job because of the low bid on earth handling which amounted to 20.7c. per cu. yd., average, in the fill. This figure included excavation and transportation of the material (14.2 to 14.5c. per cu. yd.) and a charge for placement in the dam ranging from 2c., where no artificial compaction was required, up to 6.5c. in impervious zones where specifications required spreading, moistening, and compaction by eight passes of a sheepsfoot roller. The intervening classification (where material was flushed with a hose) was bid at 4c. per cu. yd. Of the total volume 9,825,000 cu. yd. is in impervious zones and 4,875,000 cu. yd. is in pervious zones. Contract price, including change orders, will exceed $7,000,000. Design features and construction methods were described in *Engineering News-Record*, June 22, 1939, p. 846 and July 6, 1939, p. 10.

With such a low price per cubic yard, the only prospect for profit to the contractor lay in a highly efficient program of operation. Accordingly, equipment valued at about $1,250,000 was assembled and the job mechanized to a high degree in all departments. Two new types of equipment here tried out for the first time in large scale operations were the dragveyor and the Tournapulls. The former, a device for loading dump trucks, was used until many boulders were encountered in borrowpits. These resulted in so much lost time that the conventional method of loading with power shovels was resumed. The Tournapulls, on the contrary, were used continuously throughout the job, excavating and hauling impervious material, and contributed much to the speed with which the work progressed. These are motive power units mounted on a pair of large pneumatic tires designed to pull carrying scrapers at higher speeds than would be possible with a tractor. Thus this new equipment competes on a speed basis with motor trucks.

On this job the Tournapull-scraper combination averaged about 12 to 14 mph fully loaded and 16 to 18 mph empty, on level hauls. In climbing the grades to the higher lifts, the speed, loaded, was reduced to 6 or 8 mph. Tires on the Tournapulls are 24 x 32 size (80 in. outside diameter), carry 70 lb. of air pressure and cost about $1,500 each. With 15 of the Tournapull-carrying scraper units on the job, the rate at which earth was spread in 6-in. layers (and com-

pacted to about 4½ in.) sometimes reached a peak of 26,000 cu. yd. per day. Dump trucks handled enough more to bring the total per day, at the peak of operations, to about 65,000 cu. yd. However, the job average, even in full production months, was somewhat less than 70 per cent of this.

The contractor operated about 20 of his own dump trucks (12 to 20-cu. yd. capacity) and this constituted the entire truck fleet until a change in the progress schedule was called for. Thereupon subcontractors, operating about 20 more trucks, were brought on the job to speed up progress. The trucks were loaded chiefly by 5 and 6-cu. yd. electric shovels; some 2½-cu. yard diesel shovels were also used.

Material delivered by dump trucks was spread with bulldozers and was compacted, in impervious zones, under the same specifications as material delivered by scrapers. Zone 5, on the downstream face, was given no compaction other than that incidental to hauling over it and spreading the material with bulldozers. Zone 4, adjoining, had additional treatment in the form of flushing, with a 1-in. jet from a fire hose, after each 4-ft. height increase. Meters were used to make sure that the prescribed amount of water was used in flushing. Appearance of this water at the toe of the slope proved the downstream zones to be pervious, as specified.

In the impervious zones, clay and clay-sand combinations were brought from the borrowpits both by carrying scrapers and by trucks, spread in layers, sprinkled as necessary and compacted with fourteen passes of sheepsfoot rollers. Eight passes were specified; for the other six passes the contractor was paid an additional 1c. per square. Each compacted layer was required to be scarified after each sprinkling and just before a new layer was put on. This was done with a spring-toothed scarifier whose teeth were set to penetrate 3 to 4 in. (The 6 to 8-in. penetration tried at first was found to disturb unnecessarily material already compacted and the depth was reduced.) Scarification carried on in this way is believed to increase the effectiveness of bonding between successive layers.

The Tournapull units, with their 160-hp. motors, were able to make satisfactory speed over the roads and on the fill (average haul for the job about 1 mi.) but required aid in loading. As loading consisted of excavating water-laid material from the borrowpits, a very considerable tractive effort was required. Each Tournapull was helped in loading by one 125-hp tractor ahead, pulling, and a similar unit behind pushing. Thus a total of 410 hp was available for loading each scraper. With a Tournapull unit valued at $25,000 and each tractor at $10,000, the cost of the combination used in loading totaled $45,000.

**Fig. 1.** When the carrying scraper "bites in" to take its load, the Tournapull tilts without lessening the tractive effort of the 160-hp motor. When tractor hooks on ahead to help, the connection is such as to avoid interference with this tilting.

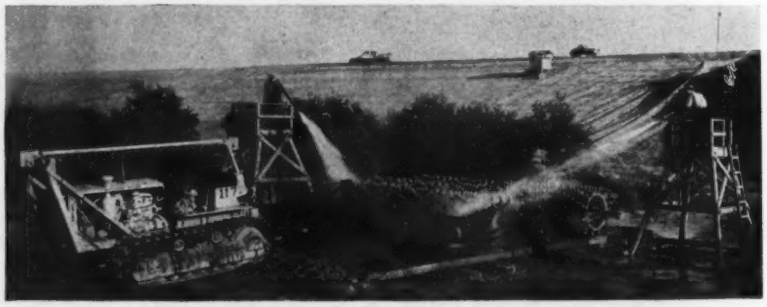


**Fig. 2.** When hard mud builds up between the tamper feet, high pressure jets clean them off over a rack (right).

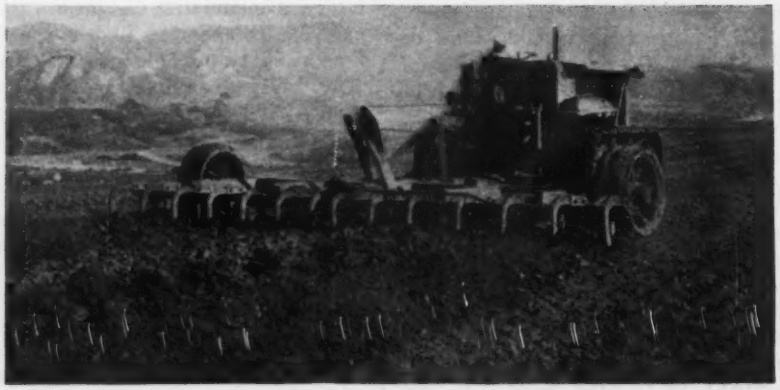


**Fig. 3.** The surface of every layer is scarified 3 to 4 in. deep to improve bond with the next layer.

Various design changes were made on the job in the sheepsfoot rollers after experimenting with different drum combinations. The combination finally adopted as best was made up of two four-drum units, side by side in a heavy steel frame 22 ft. wide. In such frames a 3½ x 6-in. solid steel draw bar was put in, from front to rear, between the two sets of four drums, to stiffen the frame. This com-

bination was found by trial to be the unit of maximum size that could be handled economically by a 125-hp tractor. Its weight was about 30 tons empty or 45 tons ballasted with water. Water ballast was used (a) when necessary to bring the tamper weight up to the specified 1,200 lb. per foot of width and (b) whenever moisture content in the fill was such that a still heavier unit weight gave better operating conditions.

On the large units, double-acting foot cleaners were used on front and rear but feet on intervening drums got no cleaning. Hence, under conditions that tended to accumulate material behind the shanks, it was necessary occasionally to hose off the drums with a high pressure water jet. This was done on racks provided for the purpose.

Wearing surfaces of the feet were renewed by welding on cast iron. To obviate the need for a jack in lifting the three-ton tongue, when the roller was to be coupled to a tractor, a sheave was mounted on the tongue with the aid of which a small cable from the tractor could provide power for raising the tongue so that the coupling pin could be slipped into place.

On two of the tractors assigned exclusively to the tamping operations, the 125-hp motors were taken out and replaced by 160-hp motors. This made the units rather topheavy, required special springs as well as other changes and would have involved risk to the mechanism from over-powering if first and third gears had not been closed off by welds. As it was these units could make better speed with the heavy tamping rollers and thus justified the special assembly.

To supplement the sheepsfoot rollers in places where clearance was limited, such as close to concrete structures and at the abutments, small, farm-type tractors were sometimes used. A great deal of hand tamping was also necessary and for this either compressed air or the explosive type (Delmag) tampers were used.

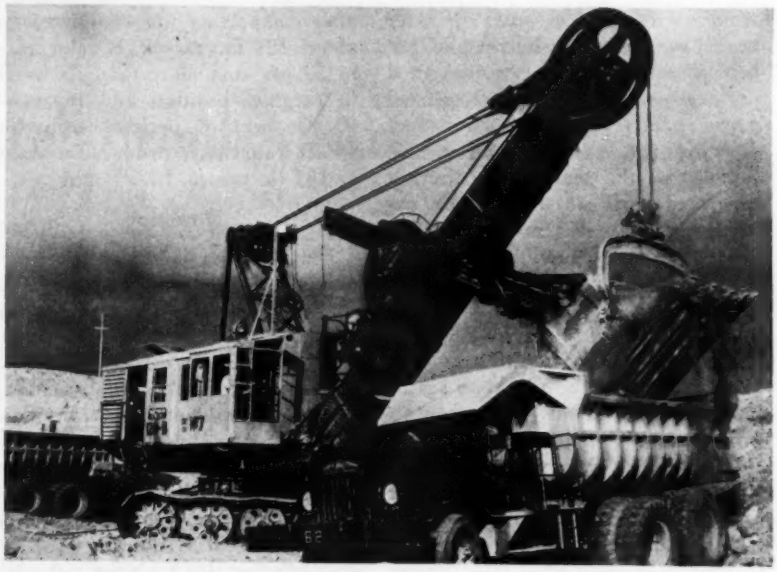


Fig. 5. Electric power shovel with 5-cu. yd. dipper loads a 20-cu. yd. dump truck.

All trucks and the 23 tractors had diesel motors. To save time in servicing, a truck equipped with air compressor for operating a pneumatic greasing system, drums of lubricating oil and grease, and manned by a crew of four, was operated three shifts daily. Part of its equipment was a 2½-kw generator for use in night lighting. This outfit could completely lubricate the largest size tractor in about eight minutes at whatever location on the work would involve least delay. Similarly, fuel oil was delivered to trucks and tractors right on the job. Including four stationary engines, there was a total of more than 90 diesel motors on this job at the peak of operations.

Embankment placing continued through three 8-hr. shifts (7½ hr. net) six days per week. All equipment was brought into the shop area Sunday morning, was inspected and repaired as necessary on Sunday and was made ready for resuming work Monday morning. Each piece was given a steam cleaning as a preliminary to inspection. The shop was a busy place on Sundays; so many special jobs of renewals and replacements were required that it was thought worth while to install shop equipment valued at $50,000. At the height of the work the Sunday shop crews averaged about 150 men.

An effective sprinkling rig for wetting down the layers of impervious material consisted of a 3,400-gal. tank delivering through a sprinkler head of the type ordinarily used in city street maintenance and equipped with a centrifugal pump able to develop a pressure of 40 to 50 lb. per square inch. The pump was driven from the second speed gear on the truck engine and hence pressure varied with the speed of the vehicle. After a few trials, it was found just what speed gave the required throw of water and the truck was then driven at that speed over the area to be wet down.

Sprinkling was varied to suit conditions that were subject to constant changes. Much advance sprinkling

Fig. 4. Three carrying scrapers moving out of the borrowpit toward the dam.

from a pipe system with sprinkler heads was done in borrowpits but here occasional clay layers prevented uniform percolation and necessitated more sprinkling on the dam than otherwise would have been required. Because of the tendency in freshly excavated earth to dry out on exposure to air, it was the rule to sprinkle on the dam just before the next layer was spread.

### Sprinkling the dam

Even when the ideal moisture content obtained in the pits, one sprinkling was always given to the top layer on the dam just before it was covered. The average was two to three sprinklings and sometimes as many as five were put on. To insure penetration and minimize evaporation the surface was scarified after every sprinkling. Time was always allowed for moisture penetration to take place between successive sprinklings on the dam.

The weight of the filled material after compaction was completed was about 124 lb. per cu. ft. This is 15 to 20 per cent more than its weight in original position and represents 95 per cent of perfect compaction which would have produced a weight of 131 lb. per cu. ft.

### Direction

Hansen Dam is under the supervision of the Los Angeles office of the U. S. Engineer Department, Lt.-Col. Edwin C. Kelton, district engineer; Capt. N. A. Matthias, chief, engineering division; Capt. Lyle Rosenberg, chief, construction division; and Wm. J. Leen, construction engineer; George J. F. Carey, area engineer, first field area; A. H. Steiner, resident engineer at Hansen Dam. The contract is held by the Guy F. Atkinson Co.; Geo. H. Atkinson, job manager; A. Earle Holt, general superintendent; D. E. Root, chief engineer; John A. Kier, assistant superintendent, and E. M. Jennett, assistant manager.

The contract price was $3,798,843 in addition to which federal expenditures will bring the total cost of the work to about $4,600,000 exclusive of rights of way. Work started in November, 1938, and is scheduled for completion May 11, 1941.

The general contract on Prado Dam is held by a combination including Guthrie Marsch-Peterson Co., Chicago; W. E. Callahan Construction Co. and J. P. Shirley, Los Angeles, and Geo. W. Condon Co., Omaha. E. E. Ashlock is general superintendent at the dam. In addition to the U.S. Engineer Department personnel mentioned in connection with Hansen Dam, K. J. Harrison is area engineer for the U.S.E.D. at Prado.

# Prado Dam to Control Floods On the Santa Ana River

PRADO DAM, which is to perform a flood control function similar to that of Hansen Dam, is under supervision of the same U.S. Engineer Department office, and subject to much the same requirements in methods of compaction, is an earthfill on the Santa Ana River about 20 miles southwest of Riverside, Calif. Much smaller than Hansen, Prado involves placement of 3,130,000 cu. yd. of embankment and is one of a series of dams in the Orange County flood control program carried out under a $15,000,000 federal aid plan (*ENR*, June 23, 1938, p. 883).

**PRINCIPAL CONSTRUCTION QUANTITIES AT PRADO DAM**

| | |
|---|---|
| Stripping for dam | 500,000 cu. yd. |
| Common excavation | 1,375,000 cu. yd. |
| Rock excavation | 2,201,500 cu. yd. |
| Backfill | 35,000 cu. yd. |
| Embankment | 3,130,000 cu. yd. |
| Average rate of placement per 16-hr. day | 10,000 cu. yd. |
| Concrete | 168,500 cu. yd. |
| Drainage area above dam | 1,491 sq. yd. |
| Elevation at dam crest | 566 ft. above sea level |
| Reservoir area at maximum water level | 8,820 acres |
| Reduction of maximum flood peak | 193,000 cfs to 9,200 cfs |

At Prado the reservoir capacity will be 325,900 acre-ft. developed by a dam 100 ft. high and 2,280 ft. long. The upstream face will have one 20-ft. berm with 3:1 slope below and 2½:1 slope above. Downstream face has two 20-ft. berms; a 2½:1 slope at the top, 5:1 between berms and 6:1 at the toe. Crest width 30 ft.

Spillway capacity, in separate structure on left abutment, is 176,000 sec.-ft. A rollway crest 1,000 ft. long, discharges through 1,200-ft. concreted channel decreasing to 650-ft. width at lower end where cellular cutoff wall goes down 80 ft. to bedrock. Outlet structure on right abutment has maximum capacity of 17,300 sec.-ft. including two 5½-ft. ungated openings. Water users infiltration system supplies discharge pipe 10 ft. below level of normal outlets.

* * *

## Sewage Treatment In South Dakota

A study of progress in sewage treatment in South Dakota since 1928, as reviewed in *The Clarifier*, official bulletin of the State Board of Health, shows that in 1928 some 51 per cent of the sewered population was discharging raw sewage into public waters. Only 27 per cent of that population was tributary to plants providing such complete treatment as sedimentation, sludge digestion, and oxidation by intermittent sand filters, rock trickling filters or activated sludge. At the close of 1939, however, only 20 per cent of the sewered population was contributing raw sewage; 64 per cent was tributary to plants providing complete treatment, and an additional 16 per cent was tributary to primary treatment works consisting of sedimentation and sludge digestion. Thus 80 per cent of the sewage receives some treatment. The largest industrial waste problem was that of meat packing plants, these wastes being equivalent to raw domestic sewage from a population of 150,000. But all of the South Dakota packing plant wastes now receive complete treatment. The report points out that the mere existence of sewage treatment facilities does not insure adequate treatment. Intelligent operation is necessary, and it is false economy for a city to spend money for a treatment plant and then neglect its operation. "If the cost of construction is warranted, so is the cost of operation."

*Electric Drive for Ordinary Jobs—IV*

# Dust- and Water-Proof Motors for Mixers

GEORGE H. HALL
Mechanical Engineer, Douglaston, N. Y.

***Contents in Brief—The simple power requirements of concrete mixers make motor selection chiefly a problem of meeting exposure conditions surrounding concrete mixing operations. Principally these conditions involve dust, rain and snow and call for motors and controls that are dust- and splash-proof. Speed reduction power transmission is an outstanding operating requirement.***

ELECTRIC DRIVE for concrete mixers is virtually limited to stationary plants. This means, generally speaking, plants of considerable capacity. Where frequent moving of the mixer to place small amounts of concrete is required or where, as in concrete paving, the mixer is continually traveling, the wiring becomes too bothersome to warrant electric drive. The contractor has then to consider only stationary plants in planning mixer electrification. Concrete mixing introduces, however, a special motorization problem in dust prevention and waterproofing.

In respect to power requirements the concrete mixer presents no exceptional problem. The power demand of mixers is practically constant so that the use of constant-speed motors is general practice and, as the mixers are started when empty, there is no need of providing motors of heavy starting characteristics. The requirements are, in the majority of cases, adequately met by squirrel cage induction motors with normal starting and overload capacities. Most of the mixers now available are equipped with such motors running at 1,800 or 1,200-rpm synchronous speed. For special cases, requiring more than a single mixing speed, multispeed, squirrel cage motors, providing two, three or four speeds, are used.

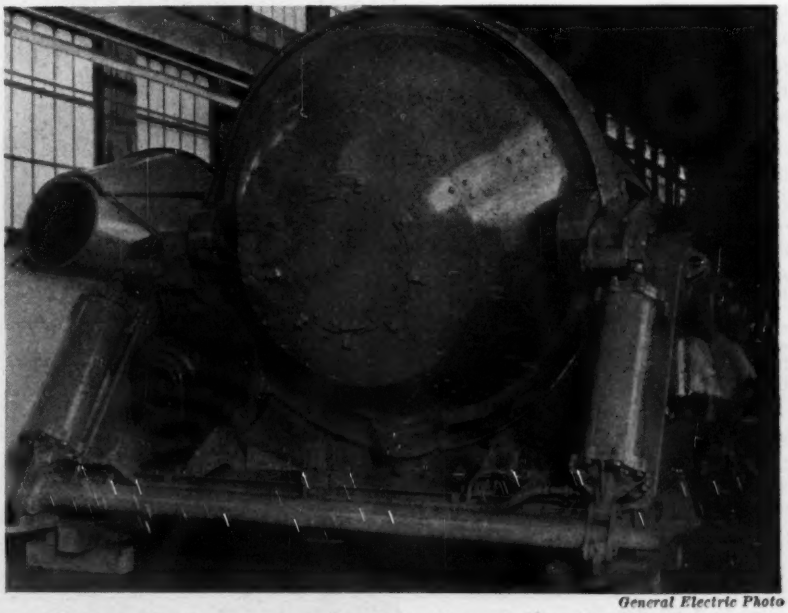
### Dust is main problem

But concrete mixing is a dusty process and motors and controls cannot be of the ordinary open construction. In particular the bearings have to be of dust-tight construction. Another requirement is that dust be kept out of the motor frame. Cement dust is not detrimental to motor windings but, by piling up around them and in the air gap, it is likely to reduce ventilation to a point at which the windings become overheated. Burnouts of motors which are frequently charged to overloads are often, in fact, due to this reduction of ventilation.

As a protection against such troubles, motors of the totally-enclosed, fan-cooled type are recommended. In these motors an adequate internal circulation of air is maintained by the use of a fan, or fans, mounted on the motor shaft inside the frame. These fans keep the air in constant flow over the windings and thence in contact with the thin enclosing case through which the heat is readily radiated to the outside. Total enclosure also prevents the entrance of dust or dirt to the interior of the frame. Totally enclosed, fan-cooled motors are rated for constant operation with a temperature rise not exceeding 55 deg. C. when carrying full load continuously.

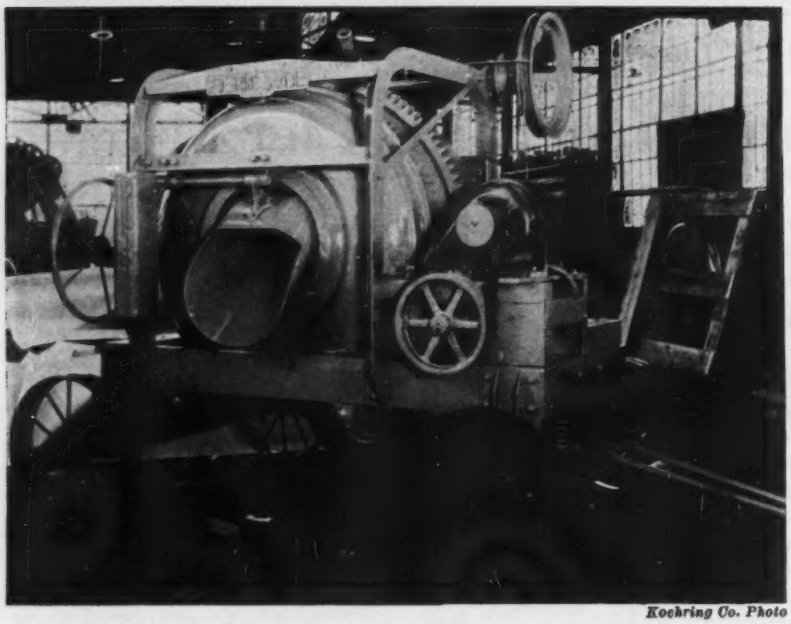
The potential dangers from cement dust in the air must also be given consideration in the selection of starters which should be dust-tight. Dust-tight starters are furnished with enclosures of cast iron or other metal, usually having a black enamelled finish on the outside and white enamel on the interior. Tapped holes are provided for the dust-tight reception of rigid conduit in which the wiring is carried. The surface between the cover and the base is machined to a tight fit. In the larger sizes the cases may be of sheet metal with a felt gasket introduced between the hinged cover and the body of the casing.

In many instances water rather



*General Electric Photo*

**A tilting mixer for heavy construction fitted with a splash-proof motor.**



Kochring Co. Photo

**Motor equipment for a small mixer on a carriage.**

than dust constitutes a danger to the motive power. This may be water dripping from the mixing drum or, in the case of out-of-door installations, water from rain or snow. A motor and control suited to operation under these conditions are known as the splash-proof equipment. Splash-proof apparatus is defined by the National Electrical Manufacturers Association standards as that which is so constructed and protected that external splashing will not interfere with successful operation. The motors and controls for this class of service are so designed that they will withstand not only occasional dripping or splashing but are not injured by direct washing with a hose.

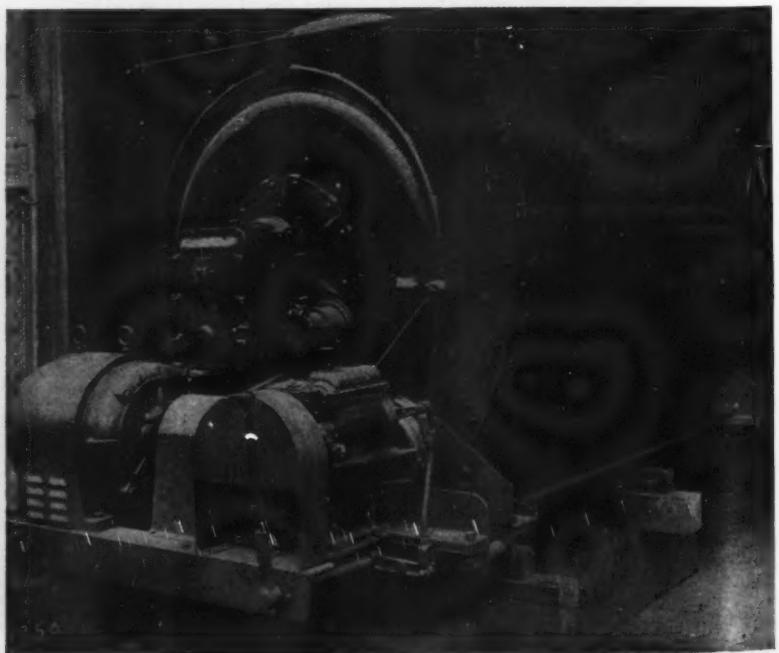
The motor frames are constructed of cast iron, protected against corrosion or rust, and are provided with bearings which are sealed against moisture as well as dirt and oil leakage. Openings in the brackets and frames, due to their louver-like shape, readily shed such water as falls upon the frames while internal baffles effectually prevent the entrance of water into the interior. At the same time, the openings are sufficient to allow natural circulation of air adequate for ventilation. The motors are classed as semi-enclosed machines and as such they are designed to carry full-rated load continuously with a temperature rise not exceeding 50 deg. C.

Starters for use with this class of apparatus are enclosed in cadmium-plated cast-iron cases and the covers, which are held in place by winged bolts, fit onto tightly gasketed joints. The cases are drilled and tapped for the reception of rigid conduit in which the wiring is installed. For use in connection with these starters, waterproof pushbuttons are supplied in place of the ordinary unprotected type. Due to the very favorable features offered by splash-proof motors and controls, they are being employed to an increasing extent for mixer operation.

### Drive and speed

The speed of mixers, that is the rotational speed of the mixing drum, is usually about 15 to 20 rpm. This, as compared with the speed of standard motors of 1,200 or 1,800 rpm, is relatively slow. The accepted form of drive is therefore a multiple speed reduction, the motor driving a countershaft through some form of geared transmission or through a multiple V-belting. From this countershaft a pinion is meshed with a large spur gear ring on the outside of the mixing drum, or the pinion and gear may take the form of chain drive. Either the chain drive or the V-belt introduces a factor of flexibility in starting which prevents heavy break-away shocks to the motor when, after long periods of disuse, the mixer has become rusty or dirt-clogged and therefore offers more than ordinary resistance at the start.

Since single-speed motors of the induction type are employed with this type of machinery, the control requirements are satisfactorily met by the use of an ordinary motor starter which may be manually operated but which is preferably of the magnetic, across-the-line type up to the allowable limits of 30 to 40 hp.



Jaeger Machine Co. Photo

**A motor operated mixer designed for truck mounting for tunnel lining.**

Such a starter provides adequate overload protection and, as it is pushbutton-actuated, the start and stop button may be mounted where most convenient for the operator without reference to the location of the starter itself. For motors of larger size, the regular manually operated compensator is adequate and this may have an auxiliary stop button placed near the stand of the operator. If multispeed motors are used, this starting equipment must be supplemented by a pole-setting switch.

When an electrified mixer is purchased, the manufacturer usually furnishes the motor equipment, or he may specify the power that will be required for its operation, leaving the procurement of the motor to the purchaser. Such recommendations, being based upon a complete understanding of the machine and of its operating functions assure the contractor that the mixer will be properly powered for all general service. While it would be impracticable and unnecessary to give here any specific figures or formula for the determination of the power requirements based solely on the mixer capacity, the actual manufacturers' recommendations for a number of mixers of various sizes may be helpful to the contractor in making his plans for the proper power supply service since the power demands of nearly all makes of mixers are in general uniformity. The capacity ratings here given are in accordance with the A.G.C. standards which allow for a 10 per cent overload.

| Cubic feet | Horsepower | Cubic feet | Horsepower |
|---|---|---|---|
| 5 | 3 | 28 | 20 |
| 7 | 10 | 56 | 40 |
| 10 | 10 | 84 | 60 |
| 14 | 15 | 126 | 75 |

The following article on electric drive for ordinary jobs will discuss hoists for cable excavators.

# Salt Breaks Ice Bond

ARTHUR C. TOASPERN
Sullivan County Superintendent of Highways
Barryville, N. Y.

IN PROVISIONS for snow removal from roads, a high-speed displacement plow or the rotary plow leaves little to be desired. But today the motorist is not content with snow removal alone, he wants a road surface free from ice, and ice removal is beyond the ability of machines alone. Ice occurs from rain freezing on the cold, bare pavement or from the compaction of snow by heavy traffic under varying temperatures. In both cases the thin layer and the close bond of the ice to the pavement make removal by scraping or picking virtually impossible. Moreover, re-formation of the ice is in nowise prevented.

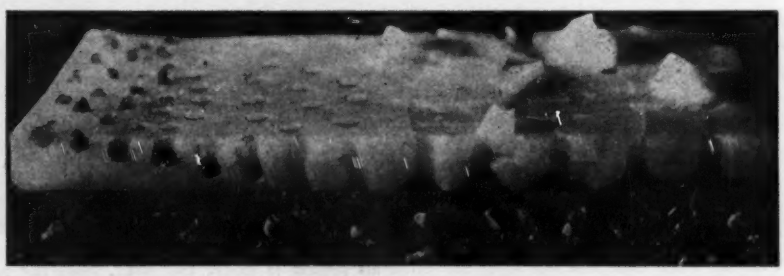
The Sullivan County highway department is solving the problem with rock salt. Sand, grit and cinders have been used but the relief is temporary, they do not prevent the formation of ice. Rock salt does and the highway department is using straight rock salt of the CC grade on curves and heavy grades.

The salt trucks start out at the beginning of a storm; they are light dump trucks, equipped with a spinner type sand or chip spreader. Bulk rock salt is loaded on the trucks and fed to the spinner through a hole in the tail gate in the proper amount to give a spread of about ¼ lb. of salt per square yard of pavement. The speed of the truck is controlled to give the proper spread.

When the rock salt is thus applied, during or at the beginning of a storm, the temperature will average between 25 and 30 deg. The rock salt soon penetrates through the snow or sleet to the pavement, forming a brine which quickly spreads, and so prevents a bonding of the ice with the pavement surface. The result of this treatment is unbonded snow or ice that can be removed at will with any blade or scraper equipment.

Illustration of the action described by pictures from actual roads shows little and a model has been developed to make the action clear. Referring to the accompanying view of the model, as soon as rock salt is applied to ice the crystals start boring downward like a carpenter's auger through wood. As crystals bore through the ice they become smaller and smaller because they are dissolved in water from the melting ice. The ice or hard-packed snow is soon riddled and drilled with holes extending from the surface of the ice to the pavement. Downward action stops when the remaining particles of rock salt and the brine they form reach the pavement surface. Brine then runs along the pavement, melting and loosening the bond between the ice above and the paving material below. Traffic passing over the honeycombed and undercut ice, breaks it into small pieces as shown and it is then easily brushed or scraped aside to make the street or roadway completely bare and safe.

The cost of this treatment is offset to a great extent by the elimination of the use of sand or cinders on roads thus treated and also a further saving in wear and tear on the equipment used in attempting to remove ice and compacted snow from the pavement. In conclusion, the experience is that a proper quantity of salt, applied at the right time, will act to prevent the adhesion of traffic-packed snow or ice to the pavement, which, in the writer's opinion, is the greatest source of danger to the highway user.



**Model illustrating action of salt in honeycombing and breaking the bond of ice on pavement.**

# Clearing the Floor of Building Services

***Contents in Brief—All piping and conduit in the new tool and die shop of the Ford Motor Co. is under the floor. Main supply lines are in large tunnels running lengthwise and crosswise of the building while distributing lines are either buried in the concrete floor fill or in underfloor trenches.***

PRESENT TRENDS indicate that the industrial building of the future will literally be built upon its services, that is, the pipes and conduits that supply its machines and processes with oil, steam, air, water and power. The ultra modern of present day plants have already put most of these services underground, and the desire to clear the working floor of all unnecessary encumbrances is unmistakable. Take the new tool and die shop at the Rouge plant of the Ford Motor Co. in Dearborn, Mich., for example.

As pictured in Fig 1, the Ford tool and die shop has an interior appearance that suggests efficiency, and cleanliness. Except for branch piping of the lighting and heating systems, no piping or conduit lines are visible. Overhead, daylight from the monitors or windows is unimpeded, and underfoot are no space-consuming obstructions. Yet machines in every part of the plant obtain their necessary services whenever the operator turns a valve or throws a switch. The secret is underfloor installation.

When construction of this building was begun the very first job undertaken was to dig two trenches 21 ft. wide and 11 ft. deep for the full length of the building at either side, and connect them with three cross trenches. Lined with concrete, these trenches became the service tunnels in which every type of supply line was installed. When the building was approaching completion, distributing lines from these tunnels were buried in the top of the concrete floor slabs. Outlets occur at machine locations or at building columns. The building services are out of sight but they are always available at the point of use.

Of the eight services required in this building seven are installed underground. The eighth, coke oven gas for use in the furnaces of the heat treating department, is brought to the building in an underground main but is carried up to the underside of the roof and thence across the building and down to the heat treating room. The seven other services are power, soda water, dust collection, compressed air, lubricating oil, cutting oil, and steam.

Power is supplied through underground feeder lines at 13,200 volts to four 2,000-kva transformer stations located in underground vaults adjacent to the power distribution tunnels. Each transformer vault also includes a lighting transformer of 500-kva capacity. Secondary power at 440 volts is distributed by open insulated cable in two longitudinal electric service tunnels to feeder breakers and thence by concealed

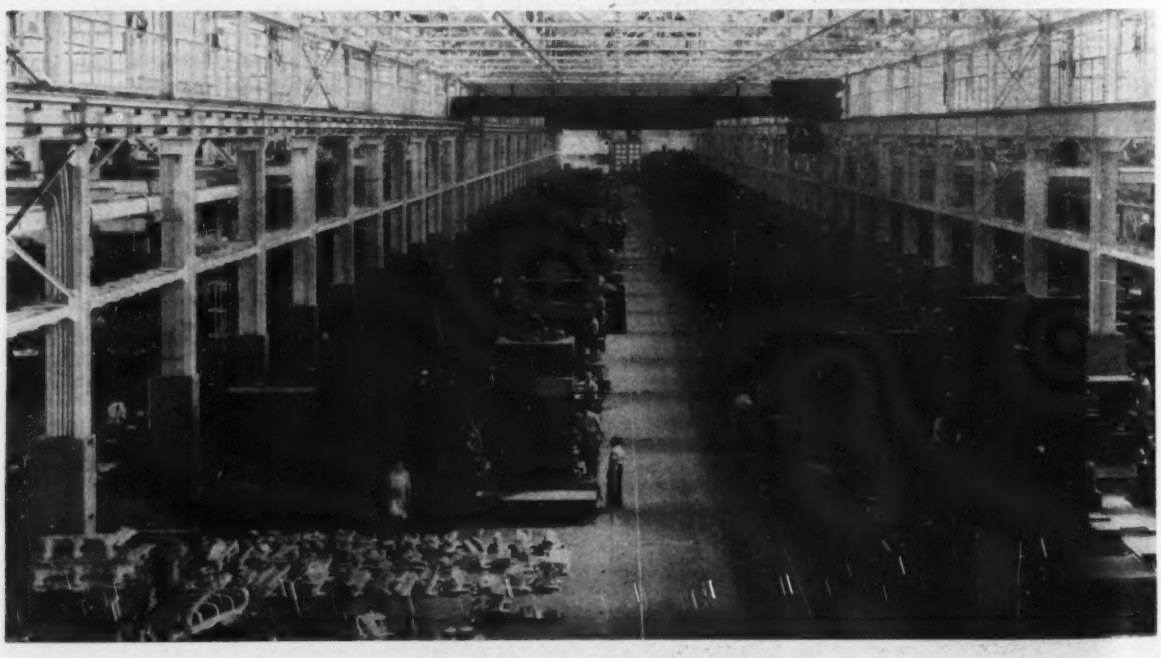


**Fig. 1.** Ford tool and die shop in which all piping is under the floor. Note the housings at each column which inclose the electric power panels and the compressed air supply outlets.

conduit to master power cabinets and high cycle motor generator sets also located in the tunnels. From here, by concealed conduit, the current is carried to the final power distribution panels, grouped around the building columns and inclosed in metal cabinets that extend 7½ ft. above the floor. Distribution from these power panels to the individual machines is through conduits concealed in a 2½-in. lean concrete fill between the structural floor slab and the wood block floor finish.

Soda water for cutting tools is supplied by a central pumping and clarifying station and returned by six auxiliary pumping stations. The main supply piping is distributed through the service piping tunnels while branch piping to the machines is concealed in the concrete floor fill. The used soda water is collected in steel lined trenches with removable cover plates at the floor line. The central station includes twin settling chambers located below the floor, each equipped with an arrangement of baffle plates and a chain flight conveyor which continuously removes sediment from the soda water.

Nine separate dust collection systems, each consisting of a fan and a group of dust collectors of the continuous-duty cloth-filler type, are located above the roof between the transverse monitors. Dust laden air from the grinding machines is collected in hoods over the grinding wheels, piped down to the floor of each machine, and collected in a duct system installed in the 5-in. space normally occupied by the floor finish and the lean concrete fill. This duct system runs to the nearest column row, and thence up to and through the roof to the dust collectors.

A loop compressed air main in the service piping tunnel with branches through the tunnel ceiling into enclosures around the power cabinets provides for distribution of compressed air.

Other supply mains in the service piping tunnel, with branches to fountains located above the main floor, bring lubricating oil to convenient points throughout the building. Cutting oil is distributed in the same manner.

Although process steam is used to only a small extent, it is supplied from pipes in the main service tunnels with trenched branches running to the heat treating department.

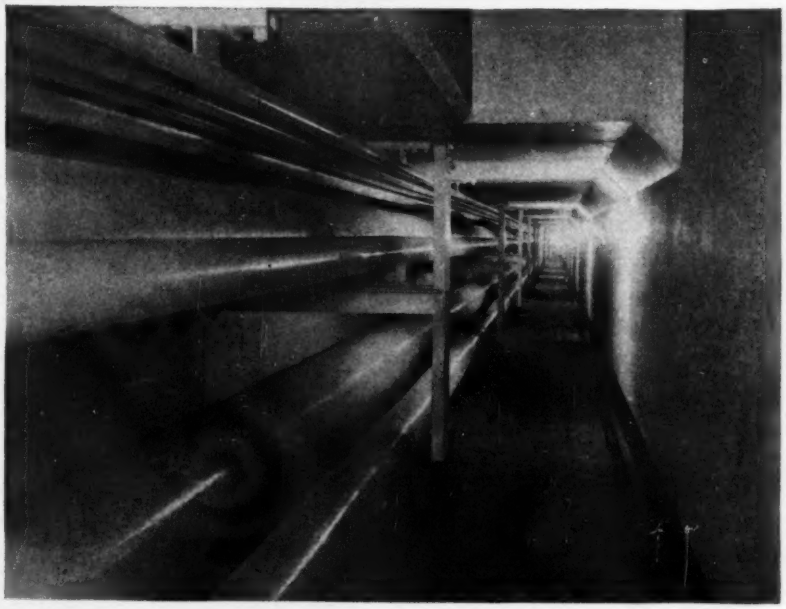


**Fig. 2.** One of the main service tunnels. Pipes carry oil, steam, compressed air, soda water and other services.

**Fig. 3.** Pipes for distributing soda water to machine tools and conduits for electric power are buried in a lean concrete fill on top of the structural floor slab.

The building was designed by Giffels & Vallet, Inc., engineers and architects of Detroit under the direction of H. B. Hanson of the Ford Motor Co. Excavation contractor was Sabadash & Sabadash. Raymond Concrete Pile Co. drove the piles, and the O. W. Burke Co. built the foundations. The structural steel was fabricated and erected by Bethlehem Steel Co., and J. A. Utley was contractor for the general architectural trades. The electrical, ventilating and soda water systems were installed by the construction department of the Ford Motor Co.

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## Largest Car-Ferry Boat for Pere Marquette Ry.

To increase its car-ferry fleet on Lake Michigan, the Pere Marquette Ry. has let a contract to the Manitowoc Shipbuilding Corp., of Manitowoc, Wis., for the construction of the largest and most powerful car-ferry steamer ever operated on the Great Lakes. It is to be 406 ft. long, with a loaded draft of 17 ft. 6 in., and twin crews driven by engines of 6,000 hp., designed to give a sea speed of 18 mph. Steam at high pressure will be supplied by water-tube boilers. Four tracks on the main deck will accommodate 34 freight cars, while 50 automobiles can be carried on the upper deck, instead of on the main or car deck, as is the arrangement on the present car-ferry steamers. The vessel is to be completed by January, 1941, and will cost approximately $1,970,000.

The Pere Marquette Ry. will then have ten steamers in its Lake Michigan car-ferry services, and the two latest boats have turbo-electric equipment for the twin screws.

# What's Ahead In Construction

ABEL WOLMAN
Consulting Engineer and Professor of Sanitary Engineering
Johns Hopkins University, Baltimore, Md.

***Contents in Brief—An analysis of past events and trends in the construction industry furnishes the evidence on which Abel Wolman builds a strong case for an optimistic view of the future. The following extracts from a recent talk before the New Jersey Sewage Works Association reveal the reasons why he believes much new work will be undertaken in the next two decades.***

DURING THE PAST TEN YEARS the United States has passed through so varied and complicated a series of basic changes that any conclusions which may have been apparent in 1939 may be viewed with less assurance in 1940. But if one reviews the economic history of this country from 1840 to 1940, only a century in the history of time, one begins to discern even in our complex economic experience some important indications of the future. Starting with the depression of the 1840's the county has experienced no less than a dozen serious depression periods, many of which were due to war either in this country or abroad.

The periods of recovery from each of these major calamities has always been long and frequently in excess of 10 years. In all of them, major liquidation has gone on disastrously for extended numbers of years. Construction of private and public works has followed in general these same rises and falls in our national economy, even though frequently a lag has occurred in construction with respect to other indexes of prosperity, depression and recovery.

### Past and present

What has been the construction experience since the World War period? In describing or analyzing that experience some of the collateral situations are worth recording as the setting within which the problem must be discussed. Since the expenditures in which we are interested rest heavily upon federal, state and local tax revenues, it is of importance to recall that in 1938 the total tax collections from these sources amounted to $14,811,000,000. This figure represented $114.09 per capita and amounted to 21.8 per cent of the average of the estimated income for the calendar years 1937 and 1938.

How much of these revenues found their way into the general construction industry?

In 1915 the total new public construction activity in the United States was only $715,000,000. It reached a peak in 1930 of $2,770,000,000. In 1939 public construction reached a probable figure of $2,800,000,000.

The total value of all construction during 1939 is estimated to have amounted to slightly less than $10,000,000,000. The total for 1939 was more than two and one-half times as large as the low value reached in 1935. Despite this increase, total expenditures on construction in 1939 were less than three-quarters of those attained in the peak years of 1926 to 1929, although the physical volume of construction last year was probably as much as seven-eighths of that reached at the peak, if adjustment is made for changes in construction costs.

From studies of the estimated average rate of growth in various items of our national economy, it is indicated that construction probably increased over the period from 1870 to 1930 at a rate very nearly the same as that for urban population, but slightly less than that for the total production of all commodities not including construction. The statistical measures suggest that the average annual physical volume of construction per capita over long periods has not changed appreciably during the past 60 years. Throughout this entire period, of course, the year-to-year changes and cyclical fluctuations have been large.

It may be concluded, therefore, that construction work in general has followed a consistent increase in volume. What of the future?

### A glance ahead

In 1930, just prior to the major collapse of our economy, Leo Wolman, in discussing public works construction, stated: "While it is impossible to make a statistical estimate of the probable expenditures on public works in the next years, it is clear that the principal agencies are behind in their programs of permanent improvements."

This prediction was followed by one of the cyclical disturbances to which reference has already been made, so that during the subsequent three years public construction was cut almost in half. This lag in fulfilling the requirements of a growing population has not been met by the stimulation which was given to public works construction by the federal financial program.

It is almost impossible to measure the future requirements for public works and maintenance, because of the many imponderable limitations involved. There is little doubt, however, in the light of the accumulated repair work, the great amount of urban street reconstruction which would be undertaken, and the requirements which arise from the growth and shifting of populations, that the construction needs of the next five years are of a magnitude at least equal to the actual construction of the late 20's.

Requirements in the highway field, and increased residential building to meet a backlog of tremendous delay in construction, represent additional imponderables which should raise the curve of construction.

When we turn, however, to the field of sewers and sewage treatment a more satisfactory picture for the

future may be quantitatively evaluated. It is reasonably clear that the next ten years should encompass a sewage treatment program for municipalities alone of approximately $1,000,000,000. This figure does not include important installations of lateral and intercepting sewers. It gives no great weight to the unsewered populations which run into thousands in our major cities and metropolitan areas. When we add to these requirements the almost complete absence of any treatment facilities for Boston, Pittsburgh, Cincinnati, Portland, Kansas City, St. Louis, Louisville, Philadelphia and others, it becomes apparent that much remains to be done. And in the industrial waste treatment field it is probable that over $1,000,000,000 will be necessary for construction purposes within the next ten to fifteen years.

These figures, representing approximately $200,000,000 of annual expenditures for construction of sewage treatment works alone for the next ten years, are believed to be conservative, since they make no provision for the repairs increasingly necessary in the older plants or for the abandonment of works which have proven to be obsolete, either because of process or equipment.

Research findings may also disclose added justifications for the treatment of sewage because it may be a carrier of some of the virus diseases. Already the finger of suspicion has been raised toward sewage discharge in connection with the spread of infantile paralysis. Whether this suspicion is confirmed or not, it and other aspects of sewage pollution control may raise the conservative figures already presented.

### Financial problems

Any review of the past performance and the future possibilities in the field of public works construction would be incomplete without some reference to the important limitations which fiscal policy and practice place upon construction activity. With rising tax rates, with mounting federal, state and local bond indebtedness, with increasing antagonism to public expenditures by the public, one can not help but be aware of the significance which fiscal policy and practice will have in future construction.

The future will require a more satisfactory advance programming for public works than has been generally provided in the past. It is surprising to note how few American cities prepare their public works budgets for much more than one or two years in advance. The mere listing and inventorying of the public improvements needed or desired in a community, provided it is based upon sound engineering review, is a first essential step to stabilize activities. A concomitant analysis of the city's financial resources, commitments and expenses should supplement the engineering construction program. Less than a dozen cities in the United States have so far developed an orderly process for long range budgeting in the public works construction field.

Every state should give consideration likewise to reasonable limitations to be established by statute for a minimum term for public works bond issues. Abuses in the past, where the term of bonds for short-life structures has exceeded in some instances 85 to 90 years, are responsible in no small degree for some of the financial disabilities with which local governments are now too frequently confronted.

ABEL WOLMAN

**The man behind this analysis of construction trends is specially qualified to speak from a broad point of view. Prior to his appointment to the Johns Hopkins University faculty in 1937, Abel Wolman for 17 years was chief engineer of the Maryland State Board of Health, and more recently PWA regional administrator for Maryland and Delaware. He is a member of the National Resources Planning Board, Maryland State Planning Commission, and Maryland Bridge Supervisory Committee.**

The programming of interest and amortization charges on past and future issues of bonds represents a fertile field for intelligent handling of construction programs to come. These in turn should be balanced against the merits and demerits of pay-as-you-go programs. This latter plan, a depression product has obvious advantages, but cannot be universally substituted for long-term bond issues necessary for constructing works of permanent and long life.

Increasing search must likewise be made for more satisfactory methods of payment for the construction of sewage works. A recent inventory of more than 100 cities, carried out by the American Public Works Association, discloses increasing use of the sewer rental plan for financing sewage disposal. This change has been rapid in the last ten years and likewise represents a depression result, since many of the cities have turned to sewer rental revenues when confronted with the impossibility of obtaining sufficient funds out of general property taxes.

A parallel tendency is exhibited in the increasing application of the toll system for highways, as exemplified in the new Pennsylvania Turnpike. These deficiencies, of course, are not new. As a matter of fact the Pennsylvania scheme is a reversion to the toll system used by the first Pennsylvania Turnpike Co. over a 100 years ago. It was abandoned many decades ago and has been revived for special purposes of the times.

The special authority scheme for avoiding general tax revenues has found new sponsors in our construction programs. These too must be carefully evaluated so as to facilitate rather than to retard adequate construction and permanent fiscal safety.

In summary, it can be said that there is no reason to suppose from the past history of construction that there will be any important abatement of such work in the next two decades. Sufficient backlog of construction necessities, normal increases in population growth, reasonable demands for increased standards of living, more satisfactory budget programming and fiscal practices, should all lead to current improvements and extensions in general works construction.

# Trailer Laboratory Speeds Soil Testing

FOR RAPID TROUBLE SHOOTING when something goes wrong on a road stabilizing operation, to locate good gravel pits, to check bituminous mixes being turned out by a contractor and in fact to do on the job almost any soil testing not calling for central laboratory refinement and deliberation, the Maryland State Roads Commission finds profit in the trailer laboratory shown by the accompanying illustrations. As described by George H. Dent of the commission's engineering staff, in a paper presented to the Highway Research Board, the trailer laboratory complete, built to the designs of the commission on a standard 22-ft. chassis, cost $2,237.

As illsutrated, the laboratory is fitted with a self-contained electric light and power plant, but is also provided with an attachment so that commercial electricity may be used when obtainable. The electricity provides light and also operating power for such equipment as the sieve shaker, soil dispersion apparatus and ventilating and drying fans. A running water supply of 36 gal. is forced through the system by compressed air; at present the air is furnished by a hand pump, but an electric compressor is to be installed in the near future. A testing oven and stove are gasoline fired and the heater uses kerosene for fuel.

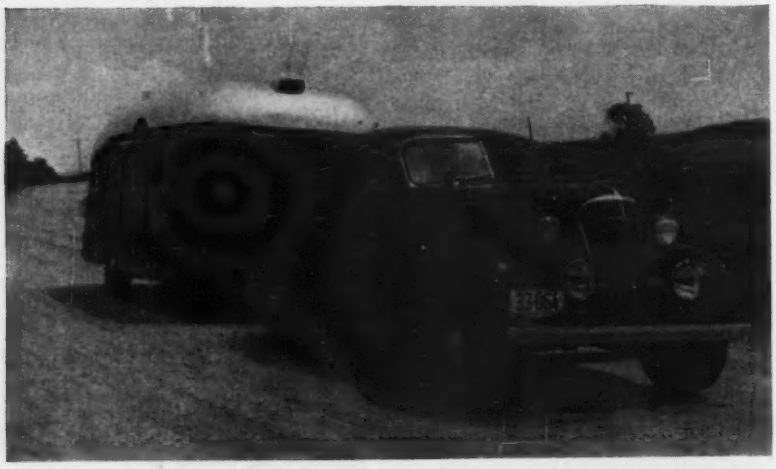


Fig. 1. Maryland highway engineers speak highly of its trailer soils laboratory.

The trailer contains equipment for the determination of the organic matter in topsoil by the Thomas rapid test method. With this mobile laboratory, it is possible to go into a field, sample, test and give the results in less than an hour. This is a saving in time of at least two days. A rigid plate holding a two-way level is mounted inside the trailer to insure that all working surfaces are level. The leveling is accomplished by means of four jacks.

Maryland, states Mr. Dent, is fortunate in having a background of test constants on some 3,000 soil samples and an experienced soils man, familiar with the geology and soil types of a territory, and given such information, can, in many cases, by a few simple operations, such as wash grading or a quick plasticity index test, identify the material and determine its suitability. The convenience of resampling encourages the securing of a more comprehensive picture of a source of supply. This added to the elimination of lost motion incidental to transporting samples, and the necessary correspondence, makes for a degree of efficiency and promptness seldom found in materials testing.

When unsuitable materials appear in gravel or borrowpits, definite boundaries of acceptable materials can usually be set up by means of a series of field tests. It is not attempted to obtain all the details or to attain the degree of accuracy given

Fig. 2. A table at the rear end of the trailer has all conveniences for computing and recording test results in the field and (right) in the forward end of the trailer are the benches, sinks, ovens and laboratory devices for conducting ordinary soils tests.

by the main laboratory. In many cases it is sufficient to find the sand or clay content, the liquid limit or the plasticity index. With this information, the contractor is offered the choice of the immediate approval of a material well within the specifications, or the delay incidental to complete analysis by the Baltimore laboratory. The contractor has always welcomed the immediate approval which causes him no delay. Due to its efficient operation, the Maryland engineers feel that the mobile laboratory is one of the best tools in a highway department's kit.

# Notes on Construction Along the Gulf Coast

*From correspondence with a staff member on the move.*

*Mobile, March 7.* Few jobs of the magnitude of Mobile's new vehicle tunnel are as easy to see as is that operation. The west portal is in Government St., right in the heart of the business district of the city, within a few blocks of the office of the engineers, Wilberding & Palmer. Standing at the waterfront near the foot of Government St., the deep cut for the Mobile approach is close at hand, and at the time of my visit one of the long caissons that are sunk in the river bed to form the under-river tube was in full view anchored nearly submerged on the opposite side of the channel. Farther downstream on that side, high and dry on the ways of a local shipyard, stood the steel shell of the last section of tube. On the Mobile side not in sight from that point, but within easy reach by boat, two other sections were tied up to a wharf that had been leased by the contractors, the Arundel Corp., having the concrete lining put in. The east portal is on an island just across the river, where a connection is made to the main highway to Pensacola.

More details of the tunnel will be given at a later date. From a construction angle, its major interest centers in the building and sinking of the 300-ft.-long tubes that will lie in the river bed. Like all jobs, big or small, this tunnel produces unexpected problems for the engineers and contractors. The first tube to be sunk to place in the tunnel was put down back of the bulkhead line across the river from Mobile in a trench with its bottom about 60 ft. below river level. Every one thought the trench had been carefully cleared of obstructions so that when concrete had been added to the shell to the amount required to just overcome its buoyancy in the brackish water of the river the tube would sink to the bottom. But after the tube had been lowered about 30 ft., it stopped short as if it had landed on some old pile tops. A line passed under the full length revealed no obstruction. After quite a bit of head scratching some one surmised that the water in the bottom of the deep trench might have a much higher salt content than the river water. A diver was sent down to take samples and they showed quite an abrupt change at about the depth where the tube stopped, the difference amounting to 0.9 lb. per cu.ft. That does not seem like much, but in a tube of the size required for the Mobile tunnel it made necessary the addition of 120 cu.yd. of concrete. When that had been added the tube went down.

### Mississippi highways

*Gulfport, March 9.* The morning following my visit to the Mobile tunnel job, J. W. Kornumpf, of the Mississippi highway department, picked me up in his car to show me some of the roadwork the department is doing in the southern part of the state. A year or so ago he had been my guide over roads farther north in the state.

Having just talked to Mr. Dowling of the Florida highway department of the effect of this winter's abnormal freezing weather on their roads, my first question was a similar one about Mississippi highways. Unlike Florida, that state had had no frost trouble with old roads; its chief trouble had been with new ones. On surface treated roads that had not had the benefit of a hot summer to dry out the subgrade and seal the top, frost caused some disintegration.

The first job we visited was on state route No. 15, the main road

**Chickasawhay River bridge on relocated state highway No. 15 in Mississippi. The main river girders are of a type used currently on Mississippi highway bridges, two 40-ft. cantilevers and one 120-ft. suspended span making up the 200-ft. central span and 100-ft. girders forming the anchor spans. The long approaches over the flood plain are 25-ft. WF beams supported on bents made of 8-in. WF-section steel pile, all carrying a 25-ft. concrete roadway.**

from Mobile to Jackson and Memphis. The section south of Hattiesburg is now being rebuilt and a considerable part of it is being relocated to improve the alignment. This involves the building of two long bridges across river bottoms.

Whenever good sand is available, the top two feet of the fills for the new road is being built with sand. Subsequently the top six inches is processed into a sand-asphalt pavement.

At Hattiesburg the highway department is building a six-mile bypass around the town for U. S. 49, the main north-south route to Gulfport. It will have a full cloverleaf intersection with U. S. No. 11, the first in Mississippi. There also will be grade separations for two railroads and three streets. A bypass for this highway at Jackson, the capital, is nearing completion.

### Dual highway at Gulfport

At Gulfport we picked up G. W. Thompson and drove along the Coast Highway to Biloxi to see Thompson's project there, making a dual highway back of the seawall that runs for 26 miles from near Biloxi to Pass Christian to end the intolerable congestion that exists on that road. Three sections totaling 6 miles are under way as a combined WPA and state highway department undertaking.

The whole coast is lined with homes built among live oaks and pines that for centuries have grown on the sand dunes well above high water. The narrow highway that serves these homes also is the through route to New Orleans. Fortunately, there is room for a wide park and a second two-lane highway between the old road and the top of the seawall. On this a new road is being built for eastbound traffic and the old road is being rebuilt as a two-lane westbound road, preserving the trees and natural formations wherever possible.

### Metarie sewer project

*En Route to Chicago, March 10.* The first stop in New Orleans was the field office of the Metarie sewer job in Jefferson Parish, a rapidly growing suburb just outside the city limits. The community, now numbering nearly 10,000, had no sewers until this work was started, and as the dense gumbo on which it is built is not adapted to cesspool disposal, conditions were getting intolerable. The area is being completely sewered and an activated-sludge sewage disposal plant is being built, discharging into one of the main drainage ditches leading north to Lake Pontchartrain.

On the way back to New Orleans we drove for a short distance on the fine new dual highway that is being built to bring the Air-Line Highway from Baton Rouge into New Orleans.

### Charity hospital settlement

Saturday morning was spent in a most interesting visit to the new Charity Hospital in New Orleans, the great building that has become the center of much interest among structural engineers and foundation authorities because of its large and continual settlement. Consisting of a 19-story central unit flanked by T-shaped extensions on each side that are 13 and 14 stories high, all carried on piles driven to El.—45 to a hard bed of sand in the gumbo that extend to unknown depths below the city. The building has settled a maximum of 13 in. in the two years that it has been up. Settlement now is quite uniform, less than ⅛ in. per month. All cracking is concentrated in the three lower floors.

Studies indicate that the only part of the frame that may need reinforcing in the future is at the chapel on one of the lower floors of the central section where a line of columns is cut to provide an open space and the load is transferred by girders to adjoining columns, two of which are outside columns. That work is now in progress.—V.T.B.

# Maintenance of Irrigation Canals

MODERN METHODS and equipment for maintenance work on large and small irrigation canals are noted in the "Reclamation Era" (U. S. Department of the Interior), in a paper by W. H. Robinson, manager of the Gem Irrigation District on the Owyhee Project, at Homedale, Idaho. Small slip scrapers with teams have developed into wheeled scrapers and carryalls for the larger canals, but laterals had to be cleaned by hand until small ditchers and V-plows were adapted to this kind of work, as it became increasingly difficult to get men and teams from the farmers. On the Gem District, built in 1912, practically all structures such as head gates, weirs, checks and culverts were built of wood, but have been replaced gradually in concrete or steel. Metal flumes on timber trestles have been replaced with concrete siphons. These permanent improvements have resulted in reduced maintenance cost and improved service.

A road grader and tractor were purchased for building roads on the canal banks, and the tractor was used to haul home-made V-plows to clean canals and slope the banks. For heavier work, a larger plow was built having timbers 24 ft. long for the wings, shod with grader blades; this was hauled by two tractors, and the wings were adjustable for banks of different heights. It worked satisfactorily on ditches up to 6 or 7 ft. deep. Then a tractor-hauled rotary scraper was purchased to remove deposits, repair breaks and make fills. The carryall type of scraper is of great advantage in all such work. Another useful machine is the dragline excavator, but it is only in recent years that it has been used for this type of work. The self-propelled dredge with an endless chain of buckets is used extensively where large quantities of silt are deposited in the canals of the district.

For the smaller laterals, single-wing and double-wing V-plows have been used, but there has been difficulty in adjusting them to the various widths and depths. To meet the conditions, a double-wing plow was built at the district shops, and is adjustable for bottom widths of 3 to 7 ft. and a maximum bank height of 6 ft. It can be hauled by a tractor on the bed of the canal or by a tractor on each bank. By giving a uniform width of ditch it insures a uniform velocity of flow and this prevents the deposit of silt which accumulates where there is a varying width of waterway. A local man has developed a one-wing ditcher controlled from a tractor and operated by one man. For economical ditch cleaning work it is considered to have great possibilities.

# Innovations in Water Supply Practice

IN WATER SUPPLY practice, as in every field of endeavor, the novelty or refinement in procedure to which we are introduced today very often is the pioneer venture which is destined to become accepted practice tomorrow. On this fact rests the justification for this special water supply section whose primary aim is to lay emphasis on developments that may be characterized as innovations.

While no claim is made that all developments reported will become models for future improvements, they do represent ingenious and in some cases bold approaches to better ways of doing things. More important, perhaps, they may serve to kindle a spark of inspiration toward even greater improvements by others. The path of progress has ever been illuminated by just such tiny sparks.

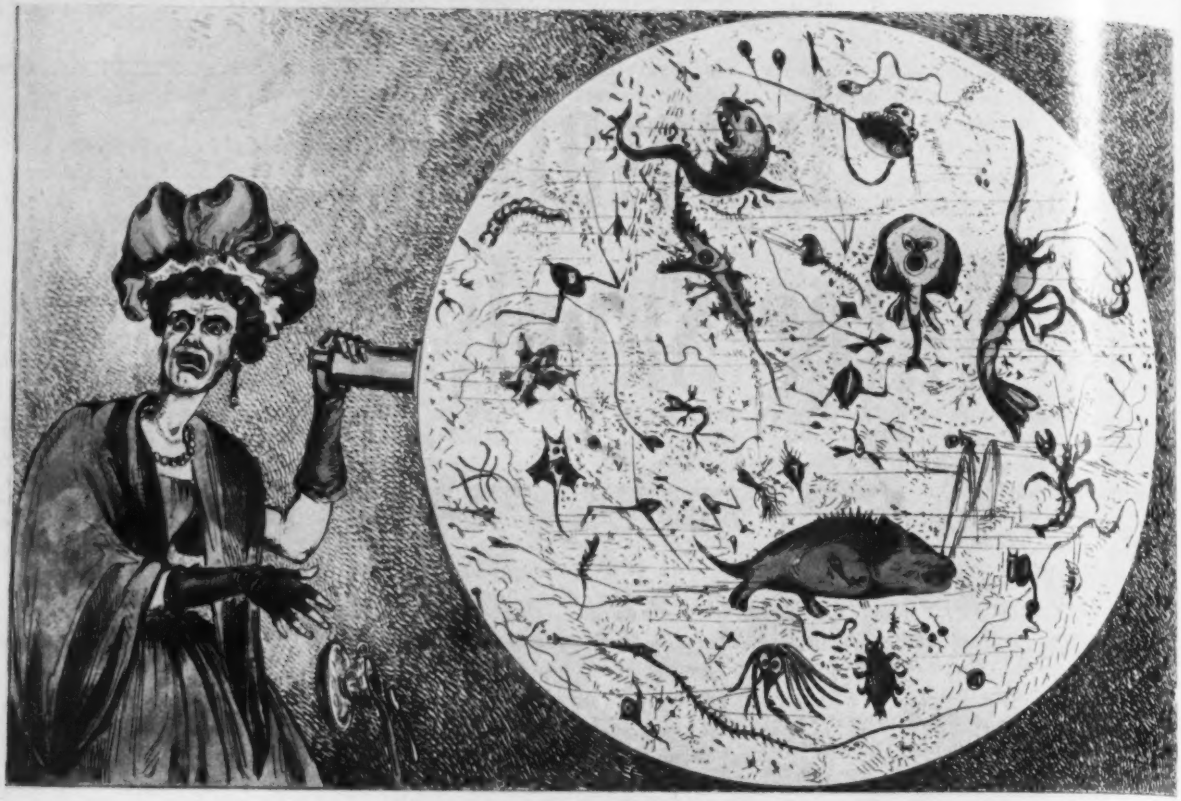
Statements are sometimes made that water supply and treatment is a static art. Nothing could be farther from fact. Not only is this belied by the record of past achievements, but by circumstances as well. Consider for a moment the virility of the industry as exhibited by these statistics compiled by *Engineering News-Record* last year: Volume of new work cost $163,000,000 on a total of almost 700 projects; meantime, operation and maintenance were being carried on as a daily routine at 12,760 waterworks. Into the design, construction and operation of this vital service went the combined thinking of the staffs of some 1,300 consulting engineers, about 1,000 equipment manufacturers and suppliers, and the personnel of almost 13,000 plants.

Could it be possible that this vast aggregation of manpower was static? The record, as typified by a few examples in this issue, proves otherwise. In the following pages the practitioner in the waterworks profession will find opportunity to make a stimulating excursion among developments all of which are novel, and most of which show promise of wide usefulness. Progress tomorrow comes from the innovations of today.

ENGINEERING NEWS-RECORD
## SPECIAL WATERWORKS SECTION

*CONTENTS*


**Water of a By-gone Day** . . . . . 82
**A Billion Gallons Not Enough** . . . . . 83
**Ozone Goes to Work** . . . . . 86
**Pinning A Pipeline on Pikes Peak** . . . . . 88
**Breakpoint Chlorination for Taste Control** . . . . . 91
**Fish Resist Reservoir Poisoning** . . . . . 92
**Putting the Damper on Surge** . . . . . 93
**Sun Ray Counts Save Sulphate** . . . . . 95
**Double Deck Settling Basins** . . . . . 98
**From Field and Office** . . . . . 101



*Monster Soup is what they called Thames water in 1827*

# Water of a By-Gone Day

M. N. Baker
Associate Editor (Retired) Engineering News-Record

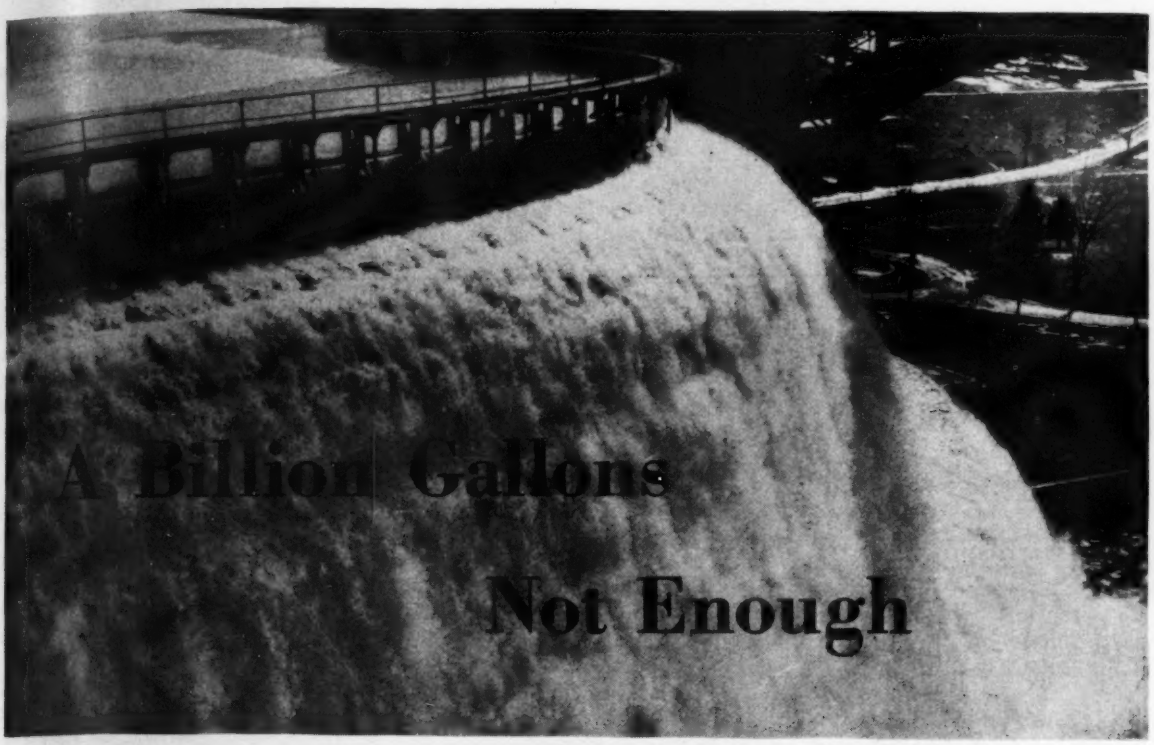
THE LATEST ADVANCES in taste and odor control recorded elsewhere in this issue suggest a backward glance of a century to the furore over the pollution of the water served by the companies then supplying Metropolitan London. The horror-stricken woman in the mob cap pictured above has dropped her tea in disgusted alarm on seeing through the microscope the little animals in the water with which the tea was made.

The colored print from which this illustration is reproduced appeared about 1827. The presumable occasion for the caricature was the appearance in that year of a thick pamphlet entitled *The Dolphin: Or Grand Junction Nuisance.* The dolphin was the intake of the Grand Junction Water Works Co., located in the Thames offshore from sewer outlets one of which led from a nearby hospital. The pamphlet gave rise to the creation of a commission on the supply of water to the metropolis.

Coincident with these events, Robert Thom built filters for the new waterworks of Greenock, Scotland, and James Simpson made experiments that led to the completion, soon afterwards, of a filter bed at London. These plants mark the beginning of large-scale slow sand filtration. The Thom plant at Greenock had a perforated false bottom and was cleaned by reverse-flow wash, two features anticipative of rapid filtration. The object of both plants was clarification. Unwittingly they removed bacteria, which for decades to come were not to be recognized as the chief dangers lurking in water supplies.

Chlorination, employed tentatively in a few places in the 1890's, but not widely used until this century, finally put one finger of death on water-borne germs. Ozonation came about the same time, but has not been used so extensively and but little in America.

In their earlier days, both chlorine and ozone were used as bactericides. Lately both have been directed to taste and odor control, and ozone to color removal also. Break-point chlorination, the latest advance in the use of chlorine gas, and the application of a new American ozonation process, are discussed elsewhere in this issue. Turn, then, from the backward glance at the imaginary horrors shown in the caricature to the latest hopes of the future based on scientific knowledge of what evils to fight and how they may best be attacked.



# A Billion Gallons Not Enough

***Contents in Brief**—Literally drinking itself dry at the rate of a billion gallons a day, New York City is now embarked on the Delaware project, which with its three reservoirs and 85-mile rock-tunnel aqueduct will add another half billion gallons to its water supply. This article is the first of a series describing the principal elements of the project. Other articles to follow will give the design and construction details of the addition being made to the world's largest water supply system.*

CHARLES M. CLARK
Deputy Chief Engineer,
Board of Water Supply New York

BECAUSE A BILLION GALLONS of water daily has proved inadequate for its needs, New York City is now embarked on a vast construction program which is being rushed to add another half billion gallons to its supply. A unique situation is presented: a city, already possessing the world's largest water system, literally faced with the possibility of drinking itself dry.

To forestall this possibility, the Delaware project is under way. This will bring eventually 540 mgd of water from tributaries of the Delaware and Hudson Rivers into the city's distribution mains. Principal elements of the project are three dams and reservoirs interconnected with tunnels, and an 85-mile pressure tunnel, longest ever constructed.

Apart from its size, the $298,000,000 Delaware project is distinguished by many innovations in both design and construction. Not the least of these is the tunnel aqueduct, which lies from 300 to 1,000 ft. below the general ground level, and at one place is 2,500 ft. under the crest of a mountain range. Other features include a caisson cutoff wall at the Merriman Dam, control works for regulating flow in the aqueduct, and provisions for interconnecting the new supply with existing sources.

The present article, first of a series intended to provide authoritative information on all phases of the Delaware project, sketches the background of the project, and outlines its relation to New York City's present sources of supply and threatening water shortage.

## Supplies exceed safe yield

The principal sources for New York's water are the impounded surface supplies of the Croton and Catskill watersheds, which have an estimated safe yield, respectively, of 300 and 510 mgd; actual delivery during 1939, however, was 295 mgd from the Croton and 610 mgd from the Catskill system. Additional water is obtained from groundwater sources on Long Island and Staten Island, from which the city-owned wells extracted 58 mgd while private water company wells furnished 61 mgd. The latter are drawing more than twice the estimated safe yield from their well sources.

The Croton watershed (Fig. 1) which now includes 12 reservoirs on the Croton River in Westchester and Putnam counties, was the first major supply project to be built. The first aqueduct on this system (capacity 90 mgd) was put in service in 1842, and a second aqueduct (capacity 285 mgd) was completed in 1890.

When the municipalities now within the boundaries of New York City were consolidated in 1898, forming a city of over three million per-

sons, the need arose for additional water. This led to the passage of state legislation in 1905 removing waterworks expenditures from the municipal debt limit, and to the creation of a Board of Water Supply. The latter was charged with the design and construction of supply works, as distinguished from the duties of the city Department of Water Supply, Gas and Electricity, which concerns itself with maintenance and operation of the supply works and distribution of the water.

The initial work of the Board of Water Supply was to develop the Catskill system, about 100 miles north of the city and west of the Hudson River. This system includes reservoirs on the Esopus and Schoharie watersheds (Fig. 1) connected by the Shandaken Tunnel, and the Catskill aqueduct from the Ashokan reservoir on the Esopus to the city. Begun in 1907, the system delivered the first water in 1915; delivery to all boroughs was accomplished in 1917. The Schoharie addition, with the Shandaken Tunnel, was completed in 1927.

Even before the full system was in service it became apparent (1921) that more water would be needed, and thorough study showed that the upper reaches of the Delaware River would be the logical source. But the Delaware, being an interstate stream forming part of the boundary between New York, Pennsylvania and New Jersey, required agreement by the states concerned on equitable apportionment of the water flow. Then followed a period of negotiation during which no agreement could be reached.

Finally, in 1927, the Board of Water Supply recommended that, as the city could afford no further delay, an immediate start be made on the work; New Jersey thereupon instituted legal proceedings to halt construction. This famous case, argued before the U. S. Supreme Court, prevented progress until the court decided in favor of the city on May 4, 1931 (see footnote).

With all legal hurdles cleared, the city was then confronted by another obstacle. No money was available, because of the economic depression. Thus it was not until June, 1936, that funds were provided to start construction of the new supply, whose need was now a matter of grave public concern. Work got under way on

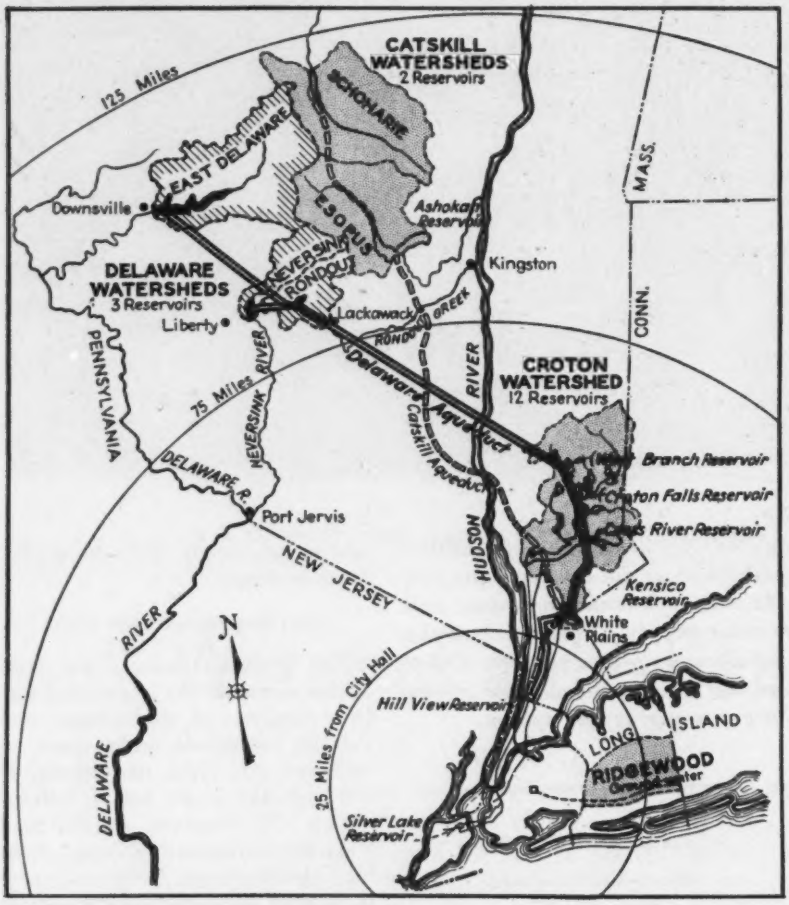



**Fig. 1.** Where New York City goes for its water. Development of the Delaware watershed with its three reservoirs and the construction of an 85-mile rock tunnel aqueduct will supplement existing sources of supply from the Croton, Catskill and Ridgewood (groundwater) systems.

For the long history of negotiation and litigation see ENR. Apr. 3, 1924, p. 585; Dec. 11, 1924, p. 969; Feb. 5, 1925, pp. 219, 233; May 7, 1925, p. 785; Feb. 2, 1926, p 209; Jan. 20, 1927, p. 100; Aug. 11, 1927, p. 210; Jan. 26, 1928, p. 170; April 25, 1929, p. 681; Feb. 2, 1931, p. 284; May 7, 1931, p. 771; May 31, 1934, p. 698; Feb. 20, 1936, p. 297; Apr. 2, 1936, p. 506; June 11, 1936, p. 858.

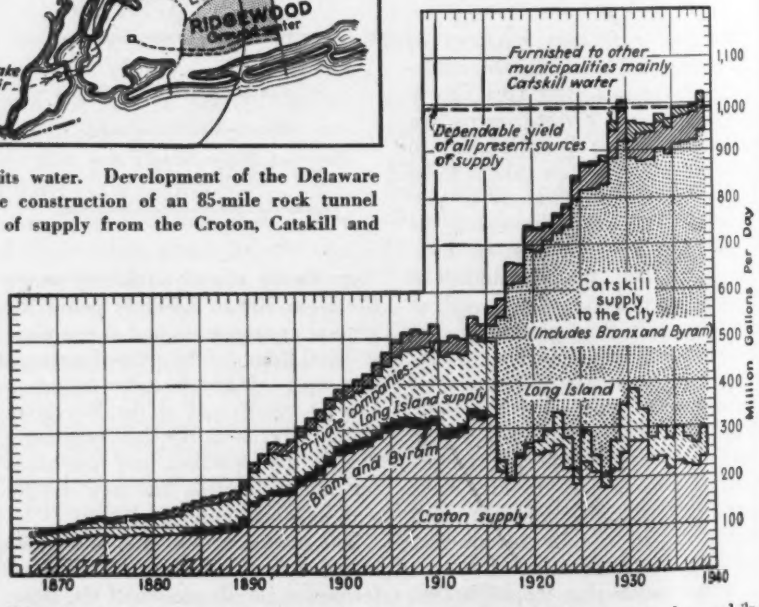



**Fig. 2.** As the years piled up so did the demands for more water and now daily requirements are more than a billion gallons. This chart shows by yearly intervals how much water was used and from where it came. Conditions are critical because consumption exceeds the available supply.

the Delaware project when bids were opened on Jan. 12, 1937, for 13 of the 30 shafts on the route of the aqueduct.

### The project today

The Delaware project (*ENR*, March 31, 1934, p. 698) provides for the development of 540 mgd of water from watersheds on the west and southwest slopes of the Catskill Mountains, this water to be brought through a continuous deep-level rock tunnel to Hillview Reservoir, located on the northern boundary of New York City. The water is to be impounded in three reservoirs, on: (1) Rondout Creek, a tributary of the Hudson River; (2) the Neversink River, and (3) East Branch, the latter two streams tributaries of the Delaware. These areas lie in a hilly region of high rainfall and sparse population; they contain little limestone, and the water produced is exceptionally soft and of excellent quality.

The work to be done was divided into two stages, the first of which is now under construction. This includes the building of the aqueduct, the reservoirs on the Rondout and Neversink, and a short connecting tunnel. By 1945, when the Rondout Reservoir and the Delaware Aqueduct are expected to be completed, 100 mgd will be made available and some water may be drawn from the Neversink Reservoir, but at the earliest no water can flow before 1944. The second stage of the work, which will probably get under way before the first is finished, includes the construction of the reservoir on the East Branch, and the driving of a tunnel to bring water from it to the Rondout Reservoir. The second stage will make available an additional 370 mgd of water.

The present status of the work is as follows:

Twenty-one contracts for the shafts, tunnels and equipment, amounting to $170,880,184, have been awarded, and five of these contracts amounting to about $10,000,000 are completed. Thus the essential contracts for the development of the first 100 mgd from Rondout Creek are in the performance stage, and others will shortly follow for work on the Neversink Reservoir. About 47 miles of the tunnel have been excavated and on 5 miles concrete lining operations have begun.

Today the shortage in the city water supply that has long been foreseen is acutely evident. When the Board began to look for new sources in 1921, the exhaustion of existing supplies by 1935 was anticipated, but the effect of the depression which made itself felt here in 1931 and of the activities of the operating department in reducing underground and plumbing leakage was to decrease the consumption; not until this year has the consumption been as great as in 1930. For the last four years the consumption has equaled or exceeded the available supply, as shown in the diagram Fig. 2; this year the average consumption was *nearly 40 million gallons in excess of the total dependable supply* of satisfactory water available.

Marked increase in the consumption was evident from last May until December, when the effect of the current campaign to reduce consumption became manifest—see Fig. 3 for a comparison of consumption with available supply for the past year. The unusually dry year of 1939 reduced the amount of water in the city's storage reservoirs to little more than one-third their full capacity (data as of Feb. 1, 1940).

In view of this grave situation the Department of Water Supply, Gas and Electricity has been restoring the wells of the city's works on Long Island to supplement the existing supplies in western Long Island, and has begun to cut down the consumption in the city by a vigorous campaign of house-to-house inspection.

### Completion dates

With the possible completion of the southerly portion of the Delaware Aqueduct from Kensico to Hillview Reservoir in 1942, it may be practicable in that year to make available a larger volume of the stored waters of Kensico Reservoir at times of peak consumption. If the aqueduct from the Rondout Reservoir to Kensico Reservoir can be finished in 1944, some additional water may be delivered from the Rondout Creek in that year, but the full supply from that stream cannot be made available before the completion of the Merriman Dam, possibly in 1946, or ten years after funds were made available for the construction of the Delaware project. The city will be fortunate if this is realized.

The Board of Water Supply has built up its staff as rapidly as possible to design and supervise the large amount of work that is now under contract. At the end of 1939 the staff numbered 1,093, of whom 923 are in the Engineering Bureau.

### Who's who on the project

The members of the Board of Water Supply are: George J. Gillespie, president; Henry Hesterberg and Rufus E. McGahen.

The Engineering Bureau has been under direction of the late Walter E. Spear, chief engineer, whose untimely death two weeks ago deprived the undertaking of the main technical guidance that brought the work to its present stage. The writer, as deputy chief engineer, is assisted by Roger W. Armstrong, in charge of the Headquarters department; Harry R. Bouton, in charge of the Eastern department; Neil C. Holdredge, in charge of the Northern department; James A. Holdredge, in charge of the Watershed department.

Consulting engineers to the Board are: Silas H. Woodard, Frank A. Marston, George A. Orrok, and Karl R. Kennison. Until his death on Sept. 26, 1939, Thaddeus Merriman was consultant to the Board. York & Sawyer are the consulting architects.

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*The second article in the series, dealing with the location and general description of the aqueduct, will appear in the April 25 issue.*

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## Training in Statistics For Engineers

Engineers and others have frequent occasion to keep and use statistical matter, and there is increasing requirement for such work, while there is little definite instruction in it. The University of Chicago has organized an Institute of Statistics to enable students to secure a statistical training through a course of evening studies. The program is designed to equip those who take the course to formulate problems and treat quantitative data. It is stated that by confronting the student with situations that require the use of his own initiative and judgment he will be trained to apply and digest statistical technique intelligently and with discretion. The administration of the course is in charge of C. F. Huth, Dean of University College.

FIG. 1. OZONE GENERATOR AND AUXILIARY EQUIPMENT AT THE DENVER, PA., WATER TREATMENT PLANT.

# Ozone Goes To Work

FREDERICK H. DECHANT
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***Contents in Brief—To meet a special problem in taste and odor control, Denver, Pa., installed ozone treatment. Thus, this borough of 2,100 becomes the first community to put into operation newely developed ozone processing equipment for this purpose. The following description of the plant includes also information on a novel type of ozone diffuser.***

OZONATION EQUIPMENT of a new type has been put to work on its initial assignment to solve a taste and odor control problem at Denver, Pa. This installation serving a community of 2,100, went into operation in March. Although operating data are not yet available, it is of timely interest to report on some special features of the plant design and the manner in which it operates.

The borough of Denver formerly depended on spring water, but increased consumption demands led to the development of a supplemental surface supply in 1938. For this purpose a low dam was built on nearby Cocalico Creek, and a rapid-sand filter plant was constructed. Plant capacity is 300,000 gallons daily.

During the drought of 1939, very disagreeable odors and tastes were experienced in the filtered water after chlorination. This condition, coupled with the fact that the citizens had for many years been accustomed to drinking untreated spring water, led the authorities of the borough to search for a means of treatment requiring the least use of chemicals. It was finally determined to install equipment for treating the filtered water with ozone as a means for removing objectionable odors and tastes as well as to sterilize the water.

The ozone installation, which has a rated capacity of 5 lb. daily, consists of three principal elements:

The air-conditioning equipment
The ozone generator itself
The diffusion apparatus to introduce and mix the ozone with the filtered water

The ozone generator which is used is the same as that recently described in *Engineering News-Record*, Feb. 1, 1940, p. 168. Ozone is generated by passing pre-conditioned air under pressure through the corona produced by the silent discharge of high tension electric current between a series of dielectric plates.

### Air dried and cooled

The air prior to ozonation is compressed to 10 lb. per sq. in. by a single cylinder carbon ring motor-driven compressor, operating without oil lubrication in the compression cylinder. Compressed air from this

machine passes through a water-cooled "aftercooler," which reduces its temperature to within 5 deg. F. of the cooling water. It is then expanded into a receiver to an average pressure of 5 lb. per sq. in. The cooling provided by the aftercooler and the subsequent expansion are intended to remove 80 per cent of the moisture content of the free air.

The remaining moisture is removed by passing the compressed air from the air receiver through chemical driers packed with activated aluminum. This chemical drier consists of two cells, one of which is in use while the other is in process of reactivation by means of warm air supplied from a small automatic blower. This equipment can be seen in the center background of Fig. 1.

From the chemical drier, the conditioned compressed air is fed to the ozone generator, or ozonator.

### Generator operation

The generator is constructed of welded steel in the form of a cylindrical-shaped pressure-tight vessel mounted on steel stanchions, and carried within it are a number of aluminum and glass plates forming dielectrict (Fig. 1). Cooling is accomplished by means of a forced circulation of the conditioned air within the generator from which the heat is extracted by an internal water-cooled copper tube radiator. The generator transformer is designed to step up the 220-volt current to 5,000 on up to 25,000 volts through seven steps. The impressed voltage regulates the quantity of ozone in the compressed air.

Normally a specially constructed ozonizer or contact column for mixing the ozone with the water is used. At Denver, we were able to eliminate the clear well itself for this essential purpose.

The ozonized air carrying about 0.5 per cent pure ozone is introduced and mixed with the filtered water in the clear well under the filters by means of Aloxite diffusers and a power-driven absorption wheel of special design. In Fig. 2 are shown the diffuser tubes and absorption wheel as installed inside a masonry gullet or trunk. The latter is so constructed that all filtered water must first pass through the gas diffusion zone and then through the absorption wheel, before flowing to the pump suction chamber.

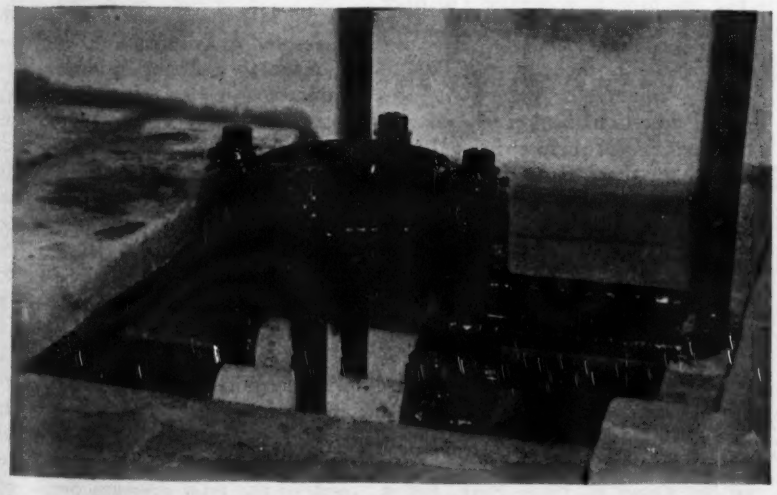

Fig. 2. Diffuser tubes and absorption wheel installed in a compartment in the bottom of the clear well.

### How the plant works

Water from Cocalico Creek is pumped from a pond in the stream created by a concrete diversion dam. The intake structure is provided with a covered trash rack, protected by fine screens. From the intake, water flows by gravity to the low-lift pumps located in a dry well constructed in one corner of the building.

Vertical low-lift pumps elevate the raw water to the coagulation and sedimentation basin of the works from which it flows onto the filters. Provision is made for the addition of alum and lime by means of electrically-driven dry feed devices. After pretreatment, the water is filtered through two mechanical gravity filters having a combined capacity of 300,000 gal. daily. The filtered water passes into a clear well constructed under one-half of the floor area of the plant and then finds its way through a labyrinth of channels to the pump suction well. Ozone gas is added to the water in the clear well by means of the diffusers and absorption wheel device.

Fig. 3. Monolithic concrete structure which houses the coagulation tanks, filters, and other treatment equipment.

In addition to low-lift pumping units and filter controls, the plant equipment comprises two 300,000-gpd high-lift electrically-driven pumps, a washwater pump, a vacuum chlorinator and a hot water heating plant.

Power for the plant operation is provided by a 50-kw, 3-phase, 60-cycle, 220-volt electric generator. This is driven by a direct-connected 3-cylinder, 4-cycle, solid injection Diesel engine.

### Who did it

The ozone processing equipment was designed and manufactured by Ozone Processes, Inc., of Philadelphia. The Denver treatment plant was designed by the writer, who also supervises its operation.

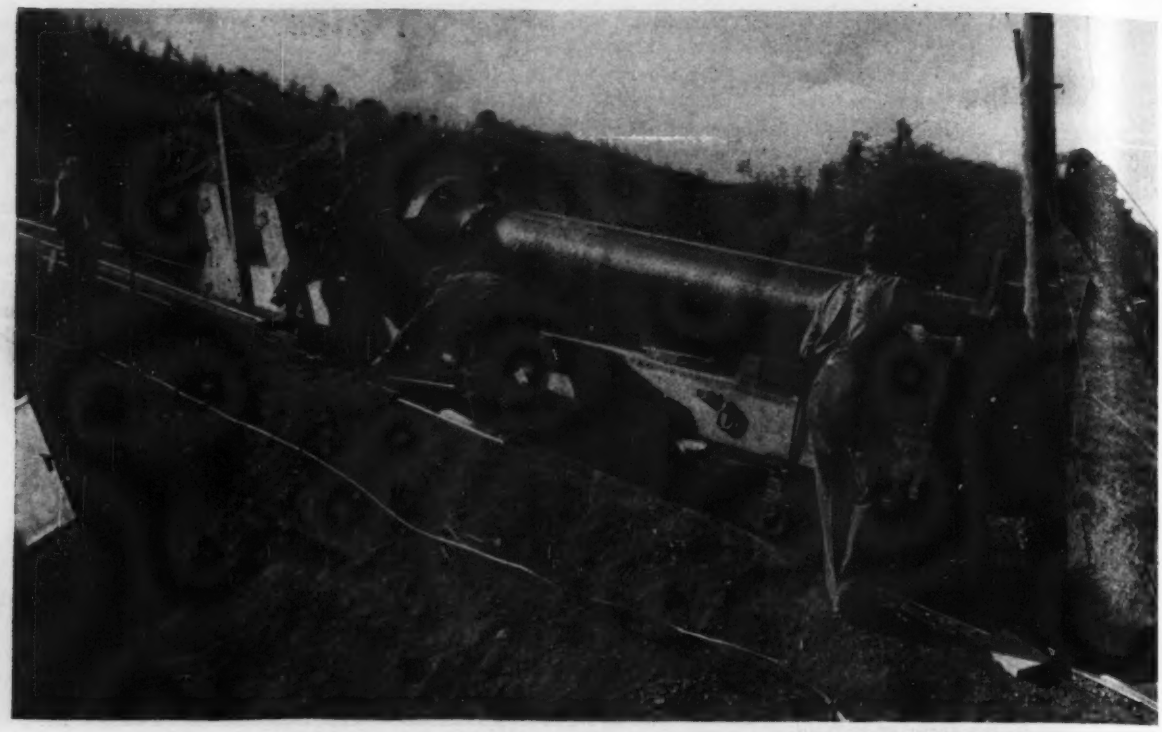

FIG. 1. UP "SHE" GOES! A 3-TON SECTION OF STEEL PIPE BEGINS THE JOURNEY TO PIKES PEAK.

# Pinning a Pipeline on Pikes Peak

E. L. MOSLEY
City Manager, Colorado Springs, Colo.

***Contents in Brief—Fastened on the steep side of Colorado's famous mountain is a pipeline whose installation raised unusual problems of design and construction. Flanged steel pipe in sections weighing as much as 3 tons was literally laid on end and anchored at frequent intervals to the solid rock. Water leaving the pipe at a pressure of over 1,000 lb. per sq.in. turns the wheels of power generators before it enters the distribution mains.***

A WELDED PIPELINE, recently completed up the steep slope of Pikes Peak, by the city of Colorado Springs, has unusual characteristics and involves difficult and novel methods of construction. It replaces a riveted steel line built in 1903, which was abandoned because of insufficient capacity and "old age." The high pressure section of the new line (1,051 lb. per sq.in. at the lower end) produced the most difficult problems, the major one being the extreme steepness of the hillside on which it was necessary to assemble the line literally on end.

Other notable features of the work included sectionalization of construction equipment before it could be hauled up the famous Incline Railway, elimination of expansion joints to maintain pipeline rigidity, anchorage to solid rock at frequent intervals and use of a limit-strength pneumatic wrench in setting up joint bolts. This remarkable penstock not only serves the main supply line for the transmission of water to the city distribution system from a chain of seven mountain storage reservoirs (*ENR*, Oct. 29, 1936, p. 599) located on the slopes of Pikes Peak, but it also makes available the incidental pressure developed for the production of electric power and light.

The length of that portion of the pipeline built in 1939 is 12,265 ft. It has a 24-in. outside diameter with walls varying in thickness in $\frac{1}{16}$-in. increments from $\frac{3}{8}$ to $1\frac{1}{2}$ in. At the upper end of this new line connection is made to a 22-in. inside diameter hammer-weld steel pipeline with $\frac{5}{16}$-in. walls, 3,359 ft. in length, constructed in 1929. The entire line, old and new, totals 15,624 ft. in length. The available maximum static head of 2,421 ft. produces a pressure of 1,051 lb. at the powerhouse. The carrying capacity as revealed by tests (with a friction head loss of 19.91 ft. per 1,000 ft. of length) is 35.64 cfs; this is the amount of water required to operate two generating units at full rated capacity. One of the interesting features of this installation is that 844 lb. or 81 per cent of the total pressure developed, is produced in the 31 per cent of line located at the lower end of the

work above the powerhouse site.

The topography of the ground upon which the 1939 portion of the pipe is built was responsible for the adoption of different types of design and construction for the low-pressure and high-pressure sections. Although covering nearly 60 per cent of the total length of the pipeline constructed in 1939, the low-pressure section, with an average grade of slightly less than 3.6 per cent develops only 113 lb. of the total pressure. This section is located along the south slope of a shoulder of Pikes Peak, where topography is so rough that five tunnels were required in order to secure desired line and grade.

### Construction problems

One of the major construction problems of the job was the transportation of supplies, equipment and material to the site of the work. With the exception of the extreme lower end, no portion of it was accessible to wagons or trucks. Fortunately the electrically operated cable railway constructed at the time the original riveted line was built, is still in operation as a scenic attraction. This railway of 30-in. gage was leased for transportation of the material on the low-pressure section of the line which goes to the summit of Mount Manitou.

From that point on construction trails and roads were built as required and ordinary means of transportation was provided. Construction equipment consisting of tractors, compressors and auxiliary booms and bulldozers was dismantled at the foot of this incline railway and hauled to the top of the mountain in units of 6,000 lb. or less.

The steel pipe used on the entire job was electrically welded by the "Unionmelt" process, only one longitudinal weld being permitted in any single piece of pipe.

Sleeve-type bolted couplings having ¼x8-in. middle rings, were used for all joints in the low-pressure section. Deflections in these couplings, both horizontal and vertical, were held to a maximum of 2½ deg. by using short lengths of pipe where necessary to accomplish the desired result.

A 22-in. flanged cast-steel Series 300 geared gate valve, weighing 3 tons, with a cast-steel adapter was used at the junction of this section with the section forming the extreme upper end of the line built in 1929.

**Fig. 3.** Cast steel fittings and anchorage at a point where the grade changes from 61 to 32 per cent.

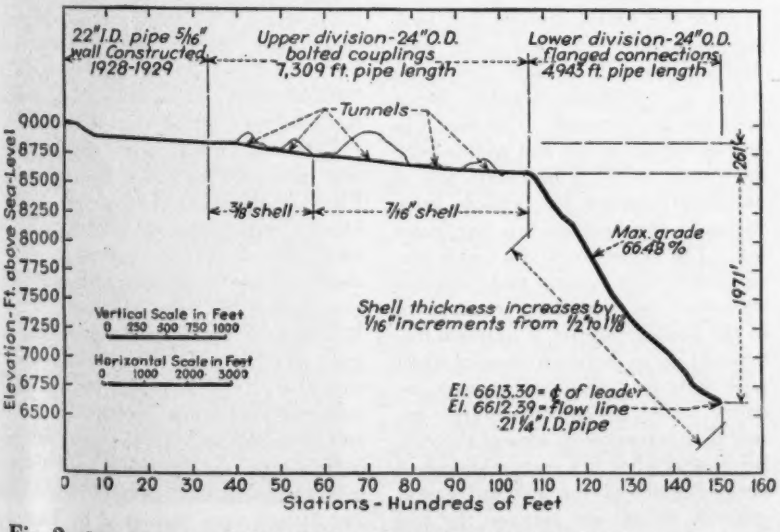
22"I.D. pipe 5/16" wall Constructed 1928-1929
Upper division-24"O.D. bolted couplings 7,309 ft. pipe length
Lower division-24"O.D. flanged connections 4,943 ft. pipe length
Tunnels
3/8" shell
7/16" shell
Max. grade 66.48%
Shell thickness increases by 1/16" increments from 1/2 to 1 1/8
Vertical Scale in Feet
0 250 500 750 1000
Horizontal Scale in Feet
0 1000 2000 3000
El. 6613.30 = ℄ of leader
El. 6612.39 = flow line 21¼" I.D. pipe
261'
197'
Elevation - Ft. above Sea-Level
9000 8750 8500 8250 8000 7750 7500 7250 7000 6750 6500
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Stations - Hundreds of Feet

**Fig. 2.** It's a long, hard climb on the route of the pipeline which has a maximum grade of 66.5 per cent. The available static head at the lower end is 2,421 ft.

The average overall grade for the entire length of 4,943 ft. of high-pressure section is in excess of 44 per cent with one continuous run of pipe 870 ft. long built on a grade of 66.48 per cent. The excavation averaged 8½ ft., much of it in solid rock.

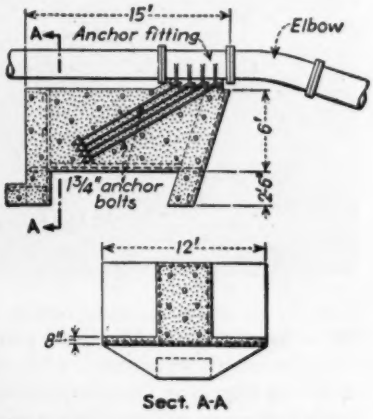


**Fig. 4.** Detail of concrete block and fitting by means of which the pipe was "pinned" to the mountainside.

For three-quarters of its length the pipe trench is located parallel to and only 6 ft. from the riveted line which has now been replaced, but which was kept in continuous service during the construction period. One of the provisions of the contract for installation was the requirement that the contractor should carry $100,000 insurance against the possibility of service interruptions, which might result from blasting and other operations. Much credit is due the contractor's organization for the manner in which this particular hazard was successfully overcome.

The narrow-gage railway was also used to excellent advantage here. The centerline was only 16 ft. from the centerline of the new work—about 10 ft. from the existing riveted line—which made it convenient to transfer individual pieces of pipe and fittings directly from the car to the trench. The advantage of this feature becomes apparent when it is remembered that a 17-ft. length of 24-in. O.D. pipe, with a wall thickness of ⅛ in., including two hubbed flanges, weighs 5,900 lb.

Owing to the high working pressure developed in this section, together with the need for pipeline rigidity and the necessity of securing proper anchorage support at key points, flanged joints were selected

**Fig. 5.** Special closure fitting which was fabricated in two pieces joined together with a threaded sleeve. The sleeve permitted an increase of length up to 3½ in.

as the best type of design available to meet these as well as other problems that presented themselves. The joints are of the Van Stone type, with square corner upset pipe ends, machined all over to specified dimensions for the various shell thicknesses of pipe, with gasket grooves in the faces of the upset ends, cut to a depth of 5/32 in. on a gasket circle having a uniform diameter of 24 in. for all pipe and fittings, regardless of other dimensions. The gaskets used were made of new live rubber, plant-vulcanized in endless rings, with a 1½-in. tubular diameter and sized to fit the gasket grooves on the ends of the pipe and fittings.

### Angles and anchors

The profile of the line shows fourteen vertical angles, five of which are located at points where the grade below the angle point is greater than that immediately above it. The change in grade at all of these points, together with the two horizontal angles near the lower end, was accomplished by the use of special flanged cast-steel elbows, with centerline radii ranging from 20 to 150 ft.

Special flanged cast-steel pipe sections, 6 ft. long, with integral bases designed to transmit the load to the heavy concrete anchor blocks, were inserted in the line at seven locations, five of them being placed adjacent to and uphill from the five special elbows required at the points where increases in grade were made.

Seven intermediate anchors consisted of blocks of concrete poured around and over flanged joints in such manner as to transmit the load directly from the flange area to the anchor without special fittings.

The pipe in the high-pressure section was laid uphill, each individual piece being set accurately to line and grade and backfilled before the next joint was made up. Special care was required in the assembly of each joint, the gasket being first set in the gasket groove on the lower side of the joint in rubber cement, with the adjoining pipe being lowered against it and brought to its proper position by means of a tapered metal guide operated by the inspector on the inside of the pipe.

After the gasket grooves had been carefully matched, the bolts were drawn up evenly around the entire joint, a pneumatic wrench being used for the purpose. This tool was a most valuable one and enabled the contractor to do a first-class job at minimum expense for bellhole excavation, a big item on this particular job. The inspector on the inside was equipped with gages and directed operations so that upon completion of the bolting process, a uniform distance of $\frac{1}{16}$ in. between faces of upset pipe ends was obtained around the entire inside circumference. The excess in cross-sectional area of the rubber gasket, after full compression had been obtained in the matched gasket grooves, flowed out between the end faces of the pipe at the joint, separating them slightly.

Since the plans contemplated the renewal of the old power plant header with a new one in the same location, it was necessary to leave this part of the work until the plant could be shut down and the replacement made with a minimum loss of plant operation in changing from the old to the new pipeline. This made it necessary for a special closure piece to be inserted between the lower end of the new pipeline and the end of the header at a point just outside the powerhouse.

### Special closure piece

This closure piece is 41 in. long in its fully extended position, of heavy forged steel construction, and fabricated in two pieces joined together by a threaded sleeve capable of reducing its overall length up to a maximum of 3½ in. This construction permitted the closure to be made without trouble, with the threaded sleeve being tightened after the gaskets had been properly placed, thus bringing the flanged ends into position for bolting in the same manner as all the other joints on this section.

Construction work was started Dec. 28, 1938, and the line was tested and placed in regular service Aug. 1, 1939. Since that date it has been necessary to shut down twice on account of leaks resulting from defects which were not discovered during inspection and testing. Repairs have been made in each case by backing off the flanges, removing the imperfect ends and replacing the joint with a bolted split sleeve, designed especially for the purpose. With the exception of these interruptions, which occurred on Oct. 25, 1939 (*ENR*, Nov. 23, 1939, p. 675) and on March 14, 1940, the pipeline has functioned perfectly.

Personnel involved in this $470,000 project, partially financed by PWA, include the following: E. L. Mosley, city manager; F. O. Ray, city engineer; C. C. Eastham, resident engineer; B. B. McReynolds, superintendent, water division; Fred W. Roberts, PWA resident engineer-inspector. The Ed H. Honnen Construction Co. of Colorado Springs was the contractor on the pipeline and foundations for the machinery installed by the Westinghouse Electric and Manufacturing Co. Pipe and fittings were furnished by Taylor Forge and Pipe Works of Chicago and inspection by R. W. Hunt.

# Break-point Chlorination For Taste Control

WILLIAM J. ORCHARD
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***Contents in Brief—Something new in chlorination technique is available for the control of tastes and odors. It involves the application of chlorine to a predetermined dose, at which point a change of condition will occur resulting in a sudden drop of residual content followed by a breakdown of taste-producing substances. This development and a method of automatic chlorination are described.***

TWO OUTSTANDING DEVELOPMENTS in the chlorination of drinking water have evoked considerable interest during the past few months. Both of them promise much for the future. The one most likely to receive immediate attention is "break-point" chlorination, since it offers a solution to one of the most pressing of water problems—elimination of tastes and odors from drinking water. The other development concerns an electrochemical method for automatic control of chlorination.

The use of greater than normal dosages of chlorine for taste and odor control has been practiced to some extent since first advocated in England by Sir Alexander Houston in 1919. It was not, however, until the past few months that the reactions occurring in water with these higher chlorine applications came to be properly understood.

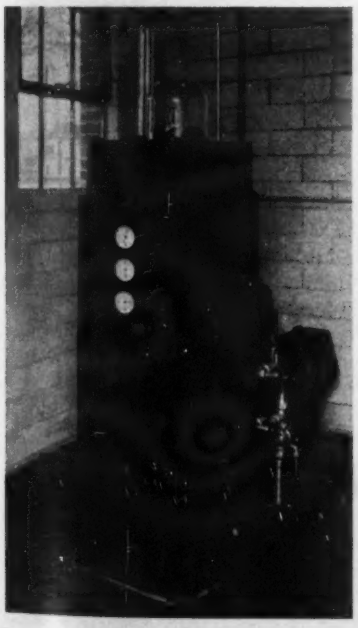

Fig. 1. **Visible vacuum chlorinator suitable for break-point applications.**

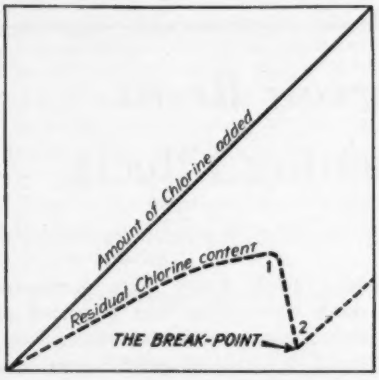


**Fig. 2. Typical action which occurs when chlorine dosage is increased to reach the break-point in residual content.**

## What it is

Chlorination to the "break-point" is a convenient way of describing this phenomenon of reaction, and the chart shown in Fig. 2 illustrates what happens in a typical water chlorinated to this break-point. With chlorination as previously practiced —using an application of from 0.1 to 1 ppm—as the rate of chlorine application increased, the residual chlorine remaining in the water increased, as shown by the dash line in Fig. 2. It is to be noted that this increase is in decreasing proportion to the application. As more chlorine is added the curve indicating residual chlorine flattens out and higher rates of chlorine application show but little or no increase in residual chlorine. (See point 1 in Fig. 2.)

As further chlorine is added the application becomes adequate to break down the taste-producing organic substances and most of the chlorine is used to oxidize organic compounds. At point 2 residual chlorine is at a minimum and tastes and odors disappear. This is the break-point. Chlorination beyond point 2 increases the residual progressively with successive additions of chlorine.

The results which have been secured by break-point chlorination in a large number of instances have been so spectacular as to be almost unbelievable. Tastes and odors so severe as to bring an avalanche of complaints from consumers have been eliminated. Sources which otherwise would have been abandoned have been continued in use, all by the simple expedient of chlorinating to the break-point.

The determination of the break-point is a scientific study requiring special laboratory technique and experience. Some waters do not have an easily recognized break-point, but in a surprising number of cases proper tests and study indicate a rate of chlorine application at which the same results are produced. Then too, on rare occasions a particular type of organic pollution will create tastes which, though greatly reduced, will continue through the break-point. Sometimes subsequent dechlorination

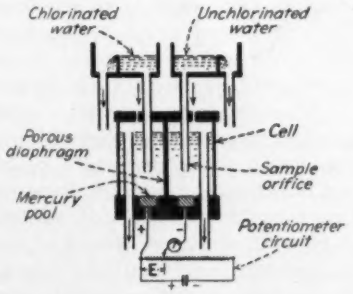


**Fig. 3. Schematic flow diagram of double mercury cell apparatus which effects automatic control.**

is indicated but if the true break-point is reached, dechlorination is not usually required.

Break-point chlorination is not likely to be a cure-all for all tastes and odors. But in a great majority of supplies, after proper study and under proper control, this technique of chlorination will solve taste and odor difficulties.

### Automatic chlorination

A second major development, first publicly discussed during the past year, is the introduction of an electrochemical method of controlling the application of chlorine to maintain the required degree of chlorination regardless of change in flow or change in chlorine demand.

Of the several types of equipment developed to employ this process one is illustrated in the schematic flow diagram shown in Fig. 3. In this apparatus there are two electrodes; one is immersed in a stream of unchlorinated water, the other in a stream of chlorinated water. The two cells are so wired that their potentials oppose each other. The differential potential between the two is transferred to a suitable recorder and, if desired, to a means for controlling the chlorine application.

With chlorine application so controlled, any desired potential may be maintained. This potential may be in the low chlorine residual ranges and, in certain sewage chlorination installations, even at some low potential level corresponding to sub-residual chlorine dosage.

Since it has been possible to correlate potentials measured and maintained by this apparatus with residual chlorine determinations and bacterial results, perfection of this equipment to the point where it can be generally employed on all water supplies may very well revolutionize the whole practice of chlorination control.

# Fish in Reservoir Resist Chemical Poisoning Effects

***Contents in Brief — Concentrations of copper sulphate and rotenone heretofore considered to be lethal in their effect on fish life were ineffective when an attempt was made to poison carp in a reservoir at San Francisco.***

RESISTANCE OF FISH to copper sulphate and rotenone poisoning was demonstrated at San Francisco when a freshwater lagoon on the Treasure Island fair grounds was invaded by more than 1,000 carp and attempts were made to poison them. The fish gained access to the reservoir when a barrier between it and a fish pond was accidentally broken.

The carp soon became a great nuisance by reason of their burrowing, which made the water muddy and threatened to puncture the watertight clay lining. (*ENR*, July 6, 1939, p. 66). Removal was attempted first by poisoning, and finally by seining. During these operations the carp demonstrated an uncanny sense of danger and remarkable resourcefulness in avoiding it. The lagoon has a depth of 33 in., a 7-acre area and a capacity of 7 mg. Overhanging stairways aggregating 1,000 ft. in length, as well as 2 or 3 in. of soft mud in the bottom, served as fish refuges.

Copper sulphate (blue stone) was first used, applied in sacks trailed behind small boats. Five successive doses were given over a period of two weeks, equivalent, successively, to 1.3, 1.7, 1.7, 8.5 and 8.5 ppm, or a total of 21.7 ppm. Thorough distribution was obtained except under projecting stairways. According to standard authorities, any one of these dosages should have provided killing concentrations for carp. Actually none was killed, although after the two heaviest doses, fish came in close to shore and were so sluggish that they could be dragged out with rakes. Nine hundred and ten were removed in this manner.

Following this, the turbidity of the lagoon water was reduced from 150 to 18 ppm within 12 hr. by a 3,000-lb. dosage (3 grains per gal.) of aluminum sulphate (alum). A final treatment of copper sulphate was then applied to the clear water to kill all remaining fish. To the astonishment of everyone, no dead or sluggish fish appeared, and within five days, the lagoon turbidity had increased to over 70 ppm.

### Rotenone ineffective

Rotenone, a constituent of derris root, was then tried in 2 per cent solution. A dose sufficient to give a concentration of 0.06 ppm, or double that reported as giving fish 100 per cent mortality in 24 hr., was applied. Twenty gallons of this liquid, purchased for $150, was thoroughly mixed with water in the main lagoon by an outboard motor and also was applied along shores and under overhanging stairways by means of a high-pressure spray. During the succeeding 48 hr., 12 sluggish fish came to the surface and were picked up from a boat. Turbidity remained unchanged.

As a last resort, the lagoon was thoroughly seined with a net 200 ft. long and 4 ft. wide, with floats along its top, weights at the bottom and a long pocket at the center. At the end of three days' work, 108 more carp were obtained whose weight averaged 0.8 lb. Several fish which eluded the net by jumping over it still remained, but turbidity was reduced to an acceptable degree.

### Copper sulphate absorption

Laboratory tests indicated that the initial doses of copper sulphate may have gone out of solution through absorption by colloidal clay in suspension and thus lost potency. In addition, the carp were very resourceful in finding refuge from poisoned water.

The work was done by the department of works, Golden Gate International Exposition, of which W. P. Day is director. Charles H. Lee, chief, division of water supply and sanitation, was in immediate charge. Laboratory tests to determine why copper sulphate was ineffective, were made by Paul A. Shaw, toxicologist, California Fish and Game Commission; G. E. Arnold, chief water purification engineer, San Francisco Water Department, made tests to determine the best coagulent for the water.

# Putting a Damper on Surge

PAUL HANSEN and PAUL E. LANGDON
Greeley & Hansen, Consulting Engineers, Chicago, Ill.

***Contents in Brief—In three long sections of water conduits in the new Lake Erie supply system for Toledo, Ohio, each required different arrangements for damping the surge. The following describes the valve and interconnection methods which were devised to meet the special conditions encountered.***

ALMOST ANY hydraulic system carrying water over long distances comparable to the layout of the new Lake Erie water supply for Toledo, Ohio (*ENR*, Jan. 4, 1940, p. 35) is subject to surge conditions. This is particularly true in a pumped supply. Increasing or decreasing the flow by the operation of the different units creates varying velocities resulting in surge waves which become critical in case of complete stoppage due to power failure.

In the Toledo project three sections of conduit and pipe are subject to surge difficulties; these are (1) the 108-in., 15,490-ft. conduit from intake to shore pumping station; (2) the 47,500-ft., 78-in. steel pipeline connecting the shore pumping station with the filter plant and high-service pumping station; and (3) a connection from the filtration plant to the distribution system involving 28,000 ft. of 72-in. steel pipe, 12,000 ft. of 60-in. and 7,000 ft. of 42-in. steel pipe.

In the intake section maximum velocities are 4.25 fps, and in consequence the surge problem is not critical since the line is open at both ends eliminating any possibility of developing either negative or excessively high pressures. The riser shaft at the Lake Erie pumping station has an overflow weir and surge outlet structure principally, however, to protect the station from being flooded by high water levels in the inlet structure which might occur when pumpage is stopped suddenly due to power failure.

The pipeline from the Lake Erie pumping station to the filter plant is designed for a maximum pressure of 150 ft. and is subject to a variation of operating pressures between 25 ft. static and a maximum of 100 ft. at maximum rate of pumpage. The design pressure was established prior to the completion of design of the pumping station and of surge studies in order to allow bids to be taken and construction started at an early date. It was necessary under these conditions to design surge control devices to limit maximum pressure to the design pressure.

### Computing surge action

The present design of pipeline and pumping equipment is based on a maximum rate of delivery of 120 mgd. The most critical surge condition exists when the pumps are delivering at this rate and all lose power instantaneously. First computations showed that the velocity of the surge wave is 3,020 fps and that the period of the pipeline is 32 sec. Without surge control devices and under the maximum conditions stated, the initial drop in pressure was found to result in a vacuum of sufficient magnitude to collapse the pipeline. Complete and sudden cut-off of reverse flow, such as would occur with an uncontrolled discharge check valve action, was computed to result in a maximum pressure of 190 ft.

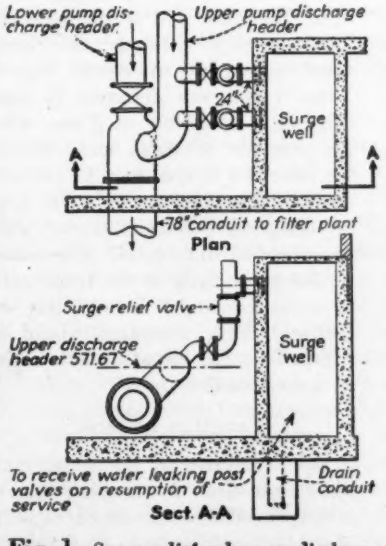


**Fig. 1.** Surge relief valves on discharge headers of pumps permit air to be admitted to the line to relieve a vacuum due to power outage.

These computations of maximum conditions demonstrated that arrangements for surge control would have to be provided to limit both minimum and maximum pressures. After extended investigations of different arrangements, in which the effect of momentum of rotating elements of the pump was considered, it was decided that the best method of controlling minimum pressure was to admit air to the pipe and the best method of controlling maximum pressures was to control the closing cycle of the pump discharge check valves.

The equipment to be installed includes two 24-in. vacuum-type angle valves, each with a 16-in.-diameter orifice, as shown in Fig. 1. These valves will permit full opening in a maximum time of 2 sec. with a pressure of not less than 10 ft. of water on the centerline of the 78-in. pipeline. When the valves open air at atmospheric pressure is admitted and closing is not initiated until all air has been expelled and water starts discharging through the orifice. Closing of the valve is completed in 6 min. with the first 75 per cent completed in 4 min. Timing is adjustable with 20 per cent. above or below the designed rates.

### Pumps have cone valves

Each pumping unit is equipped with a cone check valve in the discharge line. Operation of these valves is by oil pressure with the control valve solenoid-operated from the

pump power circuit. Thus when the power to the pump motor is interrupted, the check valve starts to close. The closing cycle is controlled to a minimum time of 75 sec. with adjustment provided to allow this time to be increased to 270 sec.

The momentum of the rotating elements of the pumping units was found by computation to be of considerable importance in controlling surges. The specifications for the pump required a minimum momentum, $WR^2$, in each unit in accordance with values found to be most effective.

### Ample safety factors

The complete design and characteristics of equipment were checked under maximum conditions and also under several other conditions. The computations show that the downsurge in the pipeline will result in pressures not less than atmospheric and that the maximum surge pressure will not exceed 60 ft. of head on the centerline of the pipeline. Because of the many factors entering into the computations and the possible variations between assumed and actual conditions and characteristics of equipment, ample factors of safety have been used and a wide range of adjustment of equipment has been provided to allow field adjustments to be made to meet actual conditions.

The third section feeds filtered water into the distribution system from the main high-lift pumping station through the trunk main made up of different sized pipe as noted previously. The feeder now under construction extends in a westerly direction across the city, intersecting existing principal mains. The larger sizes are coated with coal-tar enamel and the 42-in. pipe is to be cement-lined. In the first installation, the nearest connection to existing mains will be 15,000 ft. from the pumping station.

It is not expected that excessively high pressures will be developed in the trunk main or distribution system due to surges because of the many points of relief through service connections. The principal surge danger lies in low pressure and perhaps negative pressure which might develop near the pumping station as a result of loss of power to all pumps simultaneously. Such a condition might cause a collapse of the pipeline, pollution of the system and at least loss of service.

The general arrangement of interconnections between the several structures is shown on Fig. 2. Under normal operating conditions filtered water is drawn from the filters and the reservoir and is delivered directly through the 72-in. trunk main to the distribution system. The elevated storage tank is kept full by means of a small wash-water pump, with the storage in the tank available for washing the filters. An auxiliary connection is provided to allow the tank to be filled by the main pumping units, if necessary.

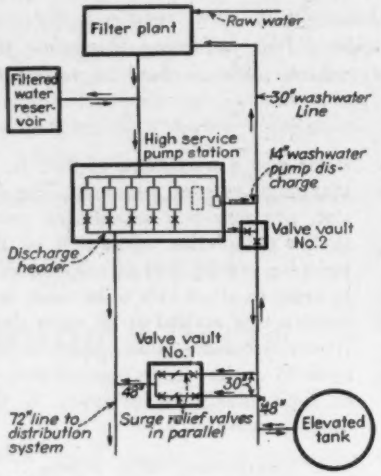


**Fig. 2.** Interconnection system at filter plant to dampen surges in trunk main to distribution system.

The elevated tank has a capacity of 1 mg with the full water level at the computed hydraulic grade line in the trunk main when the pumpage is 40 mgd. The tank and trunk main are interconnected through two surge relief valves as shown in Fig. 2. These valves are designed to open fully in a maximum of 2 sec. when the pressure on trunk main side of the valve is 4 ft. less than the pressure on the tank side of the valve. They are designed to close in 60 sec. when the pressure differential is reversed. As the surge cycle in the trunk main is estimated to be 14 sec. any excessively high pressures would be damped in the elevated tank acting as a surge tank.

### Function of tank

Low pressures in the trunk main are eliminated by making immediately available the entire capacity of the tank, which floats on the distribution system. It is estimated that the 1-mg tank capacity will provide a supply for 15 min. during periods of maximum demand which is considered sufficient to allow restarting of equipment after momentary or short time power failures. Inasmuch as the station is served from three sources of power, such outages should be infrequent and of short duration. The elevated tank, in this case, serves three purposes: (1) as storage for filter washwater; (2) as a surge tank; and (3) as reserve storage against power failures of short duration.

### Direction

The Toledo project has been designed by Greeley and Hansen under the general supervision of George N. Schoonmaker, formerly chief waterworks engineer and now city manager, Robert W. Furman, commissioner of water, and Wm. G. Clark, chief construction engineer of the Division of Water. L. G. Williams is resident engineer for the consulting engineer. Computations of surge conditions and analyses of methods of control were made in consultation with S. Logan Kerr of the United Engineers and Constructors, Inc., Philadelphia, Pa.

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## Water Softening Plant For Colorado Aqueduct

Rapid progress is being made in construction of the 100-mgd initial unit (ultimately 400 mgd) of the water softening and filtration plant for the Metropolitan Water District of Southern California, located near La Verne about halfway between Cajalco Reservoir and Los Angeles.

As this plant covers some 16 acres, the contractor can work to advantage in a number of places at once. By the middle of March most of the excavation was completed and foundation concrete had been brought up to grade with placement of 7,000 cu. yd. of concrete out of the total of 29,500 cu. yd. in the entire building contract.

Structural steel for the head house is being erected and equipment in filter and softening plants is going in. A 1-mg steel tank for washwater was completed and tested and a 1.1-mile railway siding is ready for those items of heavy equipment to be delivered.

Practically all equipment for the plant is on order or soon will be and the construction program is abreast of schedule with completion and operation of the plant scheduled for early in 1941.

FIG. 1. THE AUTHOR USING THE ULTRA-VIOLET RAY MEASURING DEVICE AT A RESERVOIR WHICH IS BEING TREATED.

# Sun Ray Counts Save Sulphate

R. F. GOUDEY
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Los Angeles, Calif.

***Contents in Brief—Contrary to general belief, there is no direct relationship between increased alga growths and high water temperatures, says R. F. Goudey. But he has discovered a relationship based on measurements of ultra-violet radiations from the sun. Records prove that this unique approach to alga control in reservoirs has paid annual dividends of $5,000 in chemical savings.***

THE INNOVATION of correlating ultra-violet radiation with alga growths in Los Angeles reservoirs as a means of determining the most effective period to administer copper sulphate treatments was first reported in *Engineering News-Record* in the April 21, 1938, issue, p. 581. Subsequent experience and records fully substantiate previously claimed advantages and the saving to the city of Los Angeles in reservoir treatments has amounted to $5,000 annually.

The present practice is to treat reservoirs when the alga counts are high or are rapidly increasing coincident with either a high total amount of radiation per day or increasing rates of intensity with no regard to warmth of water or hours of sunshine. Conversely, even though alga counts might be high but when ultra-violet radiation is low or the intensity is waning, no treatment is administered.

Our records clearly prove that there is absolutely no direct relationship between increased alga growths and higher water temperatures. Likewise, the hours of sunshine are not significant so far as quantity is concerned—sunshine is significant only in the quality of its ultra-violet ray content. It is necessary, therefore, to consider not only the total radiation per day but the maximum hourly intensity.

Radiation varies even on clear days according to seasons. In Fig. 2 are shown typical average days for winter, fall, summer, and spring normal conditions. It should be noted that in the winter time the radiation exposure is only 7½ hr. per day with a maximum of 7.4 impulses per min. (An impulse is an arbitrary unit used for comparison purposes. Impulses from the ultra-violet meter are in direct proportion to intensity of ultra-violet light reaching the meter in rays of sunlight. Yearly averages show that the impulses amount to 2,010 per day.) It is to be noted that for a two-hour period, the intensity was only 5.2 to 7.4, averaging about 6.2 per min.

During the fall, the period of radiation exposure was little over 10 hr., but the peak was not much greater than in the winter. The two-hour exposure exceeded 5.8 impulses per min. A typical summer day has over 11 hr. radiation exposure with a

peak of 10 impulses per min. and a two-hour intensity exceeding 7.3 impulses per min.

In the spring the total radiation exposure was 11½ hr. with a peak reading 13 impulses per min. with a two-hour period with an intensity greater than 12 impulses per min. It is noted that in the spring the maximum occurs at noontime, whereas in the other seasons it occurs at approximately 1:00 P.M. The areas of each curve are not proportional so far as increased alga growths are concerned because the growth apparently accelerates with increasing intensities.

### How alga growth varies

The total alga growth is almost directly proportional to the average radiation intensity. In Fig. 3 (top) are shown the monthly averages for both alga growths and radiation intensity, as well as the monthly application of copper sulphate. It is to be noted that the maximum period of alga growth, total ultra-violet radiation and copper sulphate applications are coincidal. This parallelism is too uniform to be lightly set aside as mere coincidence.

In Fig. 3 (bottom) is shown a similar relationship between alga growth, the maximum daily radiation, and the maximum radiation per minute. It is noted that the day of maximum radiation was in May, whereas the average radiation for the month was less than that of June. The maximum radiation per minute occurred in June. It is logical to conclude, therefore, that several days of high radiation are required to cause alga growths to increase unduly. In August there was a second daily maximum peak and it had a tendency to raise the average for the month of August and prevented the alga growth curve from dropping off as suddenly as it had increased during May.

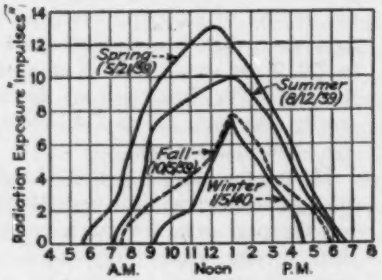



**Fig. 2.** Typical seasonal distribution of hourly radiations.

**TABLE I**

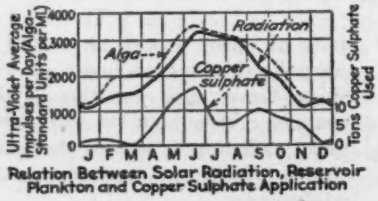
**Comparison of ultra-violet ray radiation and alga growths during a maximum heat period with similar data for a period of maximum radiation.**

| | Maximum Heat Period Sept., 1939 | Maximum U-V Radiation May, 1939 |
|---|---|---|
| Average Total Radiation/Day (Impulses) | 2,650 | 4,005 |
| Maximum Total Radiation/Day (Impulses) | 3,300 | 4,360 |
| Minimum Total Radiation/Day (Impulses) | 1,900 | 3,270 |
| Maximum Radiation/Minimum | 11.4 | 12.9 |
| Temperature Air, Mean | 90 | 97 |
| Temperature Air, Maximum hourly | 107 | 89 |
| Water Temperatures (deg. F) | 74 | 65 |
| Alga, Standard Units per ml. at start | 1,700 | 1,470 |
| Alga, Standard Units per ml. at end | 1,550 | 1,970 |
| Alga, Standard Units per ml. at change | −150 | +500 |
| Per cent hours of possible sunshine | 93.5 | 99.5 |
| Actual hours of sunshine | 11.4 | 14.1 |

That alga growths are not proportional either as to water temperature or actual hours of sunshine is indicated in Fig. 4. The water temperature reached a maximum in September which was three months after the peak growth in algae. Taking into account cloudy days and averaging the actual number of hours of sunshine per month, it is seen that the variation is only from about eight hours in the winter to twelve hours in the summer, but from May to November 1 the variation is only from ten to twelve hours which does not account for such a wide fluctuation in actual alga growths. The conclusion is inevitable that alga growths are more related to quality of sunshine rather than to its quantity. The writer has additional evidence to show that at the same radiation intensity there is greater growth in warmer water than in cooler water but it is beyond the scope of the present article to include this.

### A conclusive proof

The year 1939 in California was abnormal in two respects: first, the spring period was late and not well-defined; second, during September the weather was unusually torrid, averaging 90 deg. F. day and night for five days, with hourly maxima of 107 deg. This caused water temperatures to increase. The hours of sunshine were long and unremitting. Yet, the alga growths were actually discouraged in this period rather than increased.


Ultra-Violet Average Impulses per Day/Alga-Standard Units per Ml.
Radiation
Alga---
Copper sulphate
Tons Copper Sulphate Used
J F M A M J J A S O N D
Relation Between Solar Radiation, Reservoir Plankton and Copper Sulphate Application

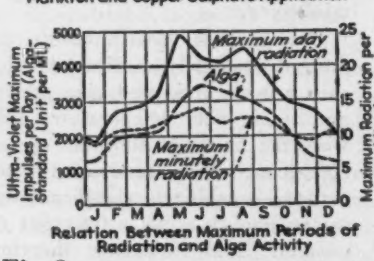

Ultra-Violet Maximum Impulses per Day (Alga-Standard Unit per Ml.)
Maximum day radiation
Alga
Maximum minutely radiation
Maximum Radiation per Minute
J F M A M J J A S O N D
Relation Between Maximum Periods of Radiation and Alga Activity

**Fig. 3.** Correlation charts of solar radiation, alga activity and copper sulphate applications.

An interesting correlation was made of ultra-violet radiation and alga growths with other related data for the hot spell from Sept. 16–21, 1939, which can be considered so far as being the maximum heat period experienced in Los Angeles, with the period of maximum ultra-violet radiation during May 21–26, 1939, as indicated in Table 1.

Of particular interest is the fact that the total variation during both periods was greater than the average for the year, but that the radiation during May 21–26, was practically twice the annual average. It is also to be noted that the minimum daily radiation during May 21–26, was 50 per cent greater than the average for the year, whereas during the hot spell it was practically the same as the annual average. It is to be noted further that the water temperature was 9 deg. higher during the hot spell than during the period of maximum intensity. The alga growths instead of increasing actually decreased during the hot period. The inference is that decreased radiation during the hot period and not the hot weather was

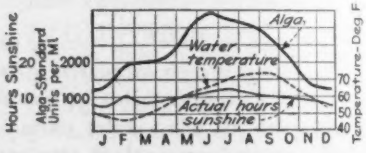



**Fig. 4.** This chart shows that alga activity are not related directly to water temperature or sunshine.

responsible for discouragement of alga growth.

Considerable improvement was made in the recording mechanism used in this work by S. M. Dunn, chief mechanical engineer of the Bureau of Water Works and Supply. In place of a chart indicating marks for every 50 microamperes developed (the reading of which was a laborious task when determining the number of impulses per minute), Mr. Dunn devised an ingenious integrating device which directly totalizes the impulses for a minute and records them on an hourly chart. The new chart is circular instead of rectangular and its spaces are so ruled into equal intensity areas that hourly and total data can be secured by inspection.

### Applying copper sulphate

It is also gratifying to report that the Los Angeles method of applying copper sulphate in a dry sugar form using a portable blower and direct-connected feeding hopper instead of using large crystals dragged in sacks alongside of boats has been steadily improved. Treatments are now adminstered in about one-third of the previous time required and with far less labor.

The final check on whether the new methods of alga control are effective is the actual reduction in the quantities of copper sulphate used per year as indicated in the accompanying table.

Fig. 5. A portable ultra violet ray measuring instrument (left) and at the right a solar-mounted type instrument.

TABLE II — DECREASED USE OF COPPER SULPHATE

| Year | Tons Used |
|---|---|
| 1933–4 | 107.5 |
| 1934–5 | 106.9 |
| 1935–6 | 99.7 |
| 1936–7 | 80.0 |
| 1937–8 | 73.6 |
| 1938–9 | 72.8 |
| 1939–40 | 60.0 |

An interesting extension in the use of the spectrograph to analyze alga growths for traces of common and uncommon elements has been initiated, but has not yet been continued far enough to warrant publication of data. This study has been undertaken in an effort to ferret out mineral influences in alga growths and thus, perhaps, establish new methods of control.

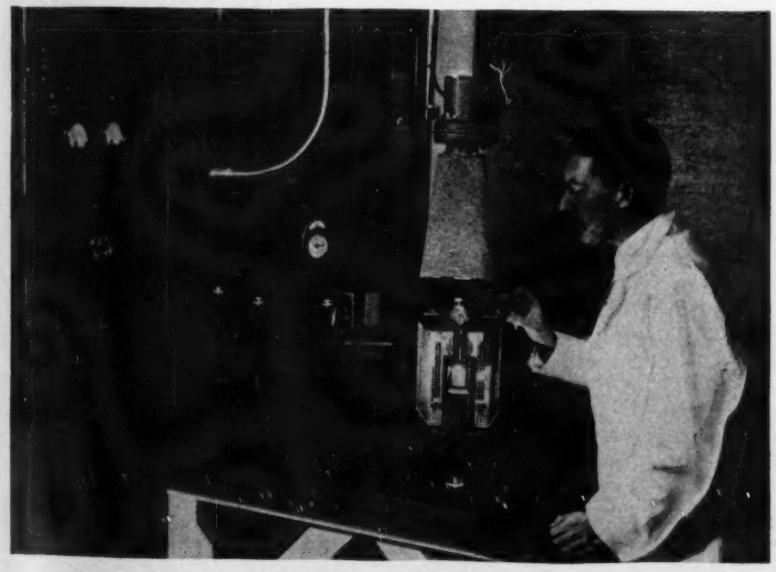


Fig. 6. On the trail of information which may lead to new methods of alga control. Here a recording arc spectrograph is being used to analyze alga growths for traces of mineral content.

## Removal of Silica With Aluminum Hydroxide

Laboratory investigations have shown that the removal of silica from water can be accomplished through the use of precipitated aluminum hydroxide, according to L. D. Betz, *et al.*, in a report given before a recent meeting of the American Chemical Society.

It is said this material may be fed to water in a slurry form. It can be used in conjunction with various alkalies such as sodium hydroxide, sodium carbonate, etc., and possesses the advantage of removing silica from solution as well as decreasing the solids content of the water. Unlike the precipitation of the hydroxide directly in the water to be treated from a salt such as aluminum sulphate or aluminum chloride, the total solids content of the water is not increased and it is possible to operate this process economically and efficiently.

Controlled conditions and maintenance of a balanced alkalinity in the treated water are necessary for efficient silica removal, which has been effected to as low a value as 0.1 ppm.

Retention time in excess of 30 minutes results in only a small decrease in residual silica. Increase in temperature at which reaction takes place tends to decrease the efficiency of silica removal. At temperatures in excess of 70 deg. C. relatively inefficient silica removal is effected.

The use of aluminum hydroxide is also adopted to function with cold process line and soda softening.

# Double-Deck Settling Basins

LORAN D. GAYTON
City Engineer, Chicago, Ill.

***Contents in Brief—Chicago's water filtration plant now under construction includes two-story settling and coagulation basins. Here is the story of why this type of design was chosen and how the tanks will operate.***

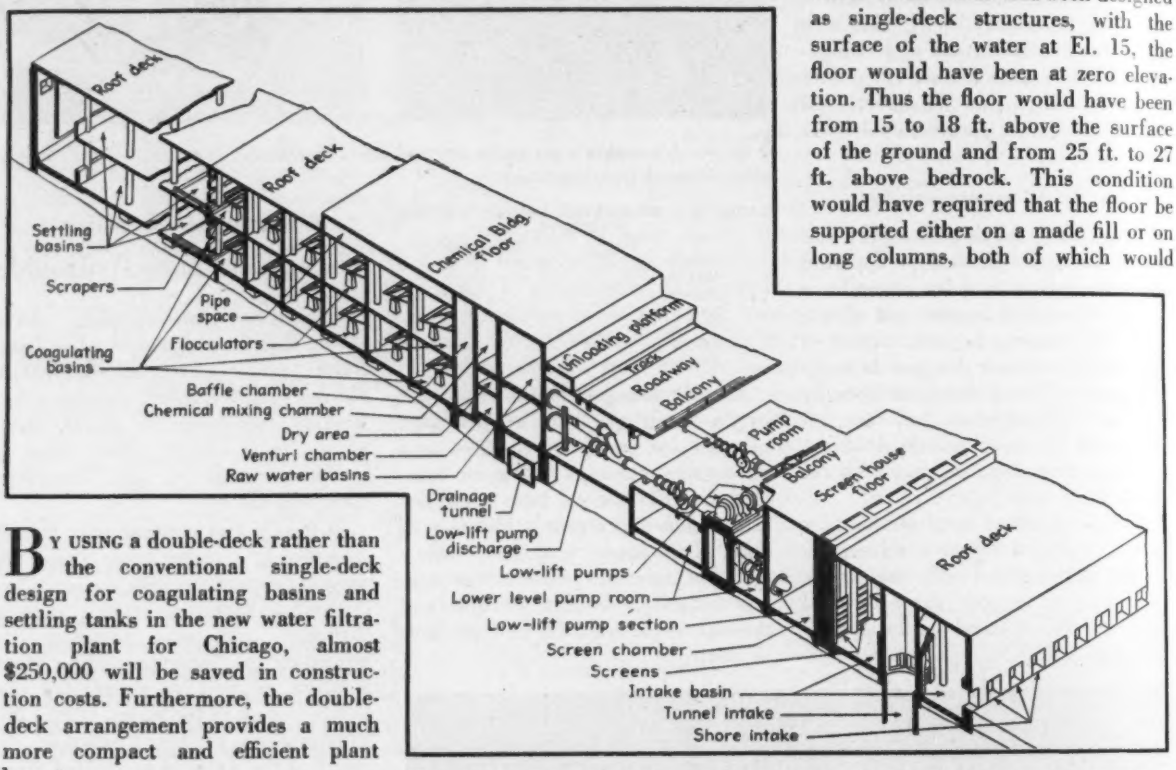



**Fig. 1. Double-deck design of the coagulating and settling basins in the Chicago filtration plant will save about $250,000 in construction costs and at the same time provide a more compact layout. This isometric longitudinal section shows the relation of principal plant structures.**

BY USING a double-deck rather than the conventional single-deck design for coagulating basins and settling tanks in the new water filtration plant for Chicago, almost $250,000 will be saved in construction costs. Furthermore, the double-deck arrangement provides a much more compact and efficient plant layout.

Requests for information concerning these double-deck basins indicate there is some misunderstanding as to why this particular design was adopted. The following explanation may be found helpful.

First, it should be stated that the Chicago plant will supply filtered water to three pumping stations on the south side of the city—Roseland, 68th St. and Western Ave. From the filtered water reservoir of the filtration plant, the water must pass through 2 miles of tunnel to reach 68th St. station, 9 miles of tunnel to Roseland station and 10.5 miles of tunnel to reach Western Ave. station.

To overcome loss of head in the tunnel system under maximum pumpage demands, it was desired to fix the filtered water reservoir level at El. 3 (Chicago datum). To provide for gravity flow through the plant it was necessary that the surface of the raw water basins be at El. 19; this determined the settling basin water level at El. 15 (See *ENR*, Nov. 23, 1939, p. 682, for plant description.

Beneath the coagulating basins and settling basins, the ground or lake bed elevation varies from minus 15 to minus 18, and the bedrock elevation under the same area varies from minus 24 to minus 37. The bedrock surface is uneven, and in some locations, within the bulkhead area it outcrops above the bottom of the lake.

For efficient operation a settling basin was desired with 15-ft. depth of water. If the basins had been designed as single-deck structures, with the surface of the water at El. 15, the floor would have been at zero elevation. Thus the floor would have been from 15 to 18 ft. above the surface of the ground and from 25 ft. to 27 ft. above bedrock. This condition would have required that the floor be supported either on a made fill or on long columns, both of which would have been extremely expensive. In addition, the use of a single-deck settling basin would have called for a larger and much more expensive cofferdam than the one actually used.

By using a double-deck design for the coagulating basins and the settling basins, nearly $250,000 in construction costs will be saved and a much more compact and efficient plant layout will be provided.

### Method of operation

It should be noted that the Chicago coagulating basins and settling basins are operated in parallel.

whereas double-deck basins previously adopted for the Milwaukee and Fort Wayne plants are operated in series. In the Chicago settling basins the water moves in a straight flow line from the entrance to the exit without reversing its direction of flow, whereas in both the other installations the water reverses its direction of flow in passing from one deck to the other. In reality the Chicago plant has six separate and distinct coagulating basins and six separate and distinct settling basins.

In the Chicago plant, under average operating conditions, there is a detention period of 58 min. in the coagulating basins and 4 hr. in the settling basins, whereas under maximum operating conditions 35 min. is available in the coagulating basins and 2½ hr. in the settling basins. Provision is made for rapid mixing of the chemicals before the water enters the coagulating basins. In one third of the length of the basins transverse scrapers drag the sediment on both floors to one side where cross collectors convey the sludge to concentration sumps.

The coagulating basins will be equipped with mechanical agitators fastened to horizontal shafts. The conduits are somewhat of the nature of the around-the-end type of coagulating basin with the water being agitated but traveling forward much slower than is general for such basins. The water, therefore, will be traveling in the direction of the centerline of the agitating device instead of across the line of the agitators as is the frequent custom in constructing the flocculator type of basin.

The water will flow through slots in the wall separating the coagulating basin from the settling basin. These slots will be provided near the bottom of the wall, near the center and near the upper part of the wall. This arrangement provides flexibility so that it will not be difficult to change the level at which the water enters the settling basins should operating experience indicate that a change is desirable.

### Multiple-deck clarification

The idea of clarifying liquids in multiple-decked shallow settling basins is not new, for this process has been used in various industries, and it has been proposed for the clarification of water. The Gilchrist clarifier, used successfully in various industries, is an example. The influent enters at the top and the solids are settled out on numerous shallow trays placed one above another. A scraper removes the sludge from each tray into the hopper bottom of the basin in a continuous process. Settled liquid flows from the top of each tray continuously. Under favorable conditions it is claimed that the settling period would be half that of an equivalent plain sedimentation basin.

The Super Settler of the International Filter Co. is an adaptation of the idea of settling on multiple-deck shallow basins with continuous sludge removal. This equipment is adapted to situations where rapid clarification of comparatively small quantities of liquid are concerned, and where the space for installation is limited.

In 1913 the Jewell Water Improvement Co. of Chicago submitted a design with two double-deck settling basins for a filtration plant. The coagulation basin was in the center between the two double-deck settling basins operating in series. The water passes first through the lower basin, then rises and reverses its flow, passing back to the outlet of the upper deck near the point of entry. Although proposed 27 years ago, the plan embodies some of the ideas put forth at the present time to provide horizontal flow through the basins.

Fort Wayne completed a rapid sand filtration and softening plant in 1934 and as far as the writer knows this was the first large plant to use double-deck settling basins. The reason for using double-deck settling basins is given by R. L. McNamee, one of the consulting engineers, as follows: "By reason of the necessity for building the entire plant upon a

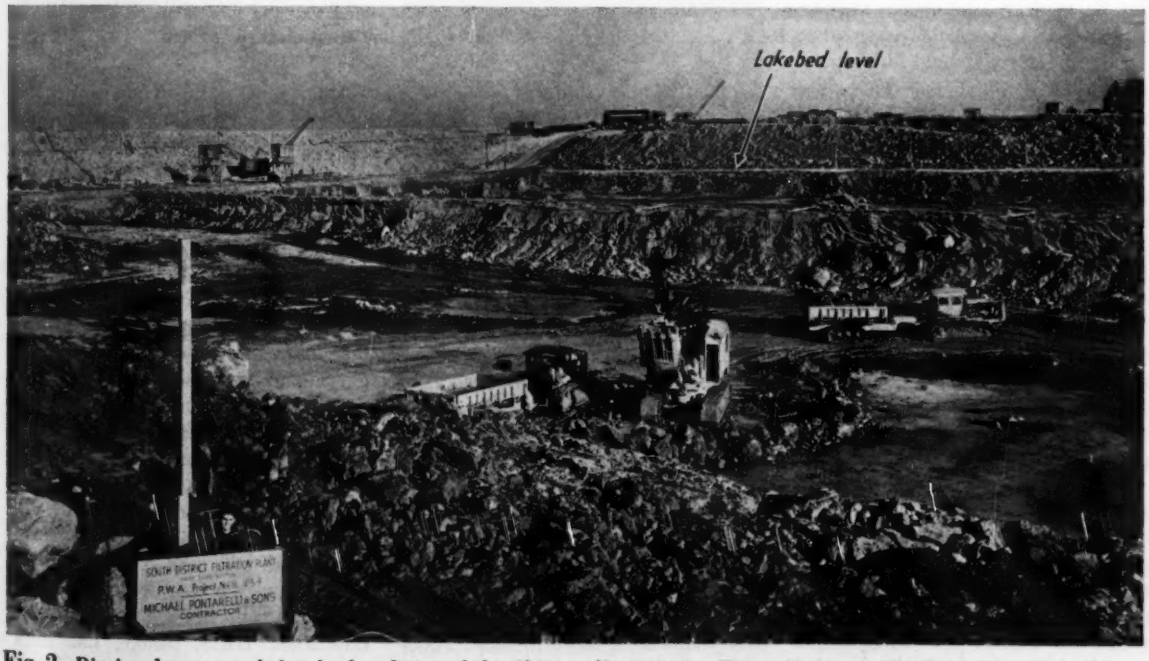



**Fig. 2. Digging down to rock for the foundation of the Chicago filter plant. The cofferdam holding out the waters of Lake Michigan surrounds an area of 38 acres from which glacial till and blue clay are being stripped.**

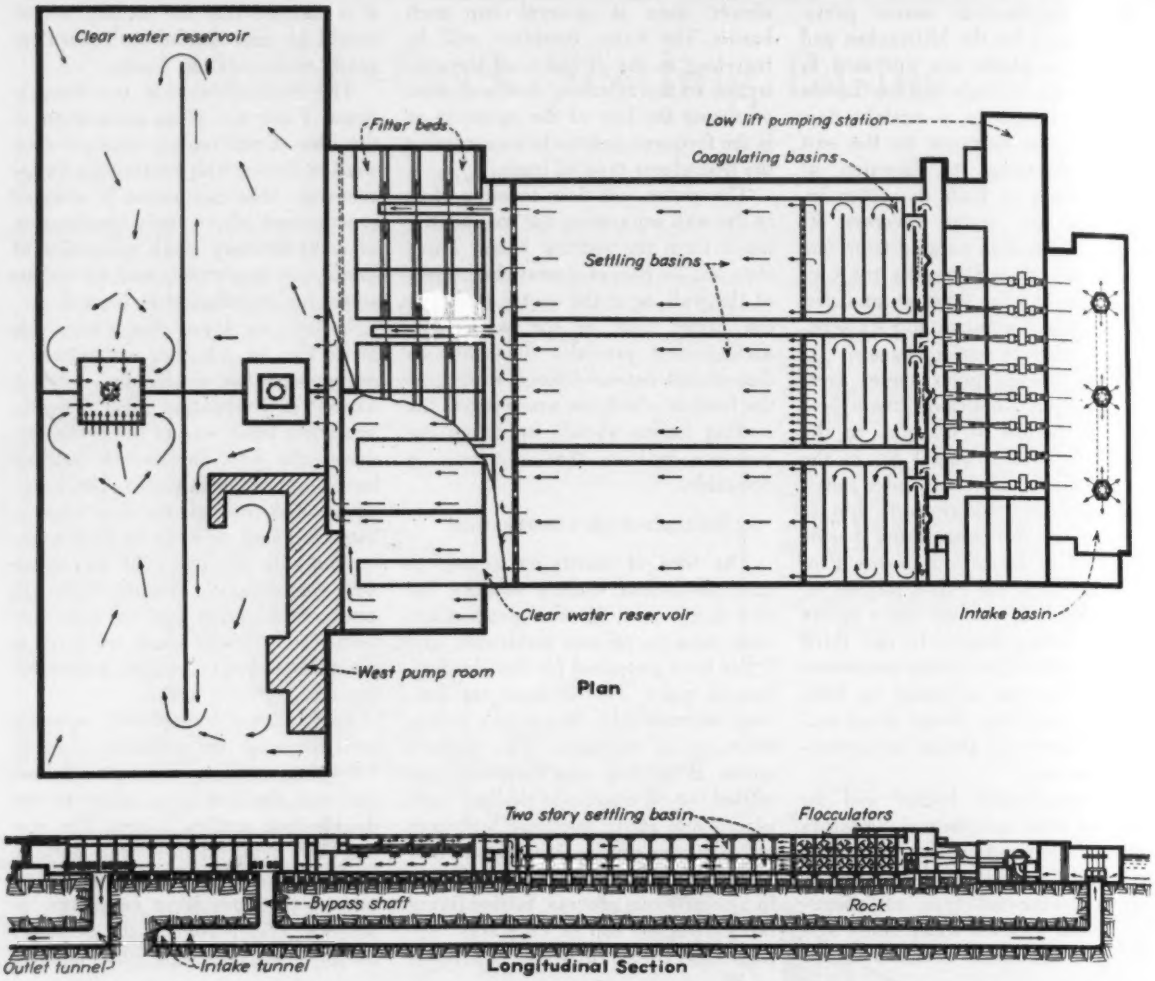



**Fig. 3.** Path of water travel through the South District filtration plant. It will be noted that the flow is in parallel through the double-deck coagulation and settling basins, and the water moves in a straight line from entrance to exit.

foundation of piles, every effort was made to concentrate the several units into as small an area as possible and to load the pile system uniformly to its designed capacity. One result of this plan is the construction of the settling basins as two-story tanks, one above the other. The water flows first through the upper basins, which are 15 ft. deep, thence over a weir and through a down shaft into a lower story of the same depth, returning at the end of this pass to an outlet having its gradient at the level of the upper tank."

### Milwaukee installation

In 1939 Milwaukee placed in operation a 200-mgd filtration plant, and it is believed that this was the second installation of double-deck basins. The reason for adopting this design is given by L. R. Howson of Alvord, Burdick & Howson, consulting engineers, as follows: "Originally it was planned to use single-story around-the-end basins. However, on account of the low elevation of the ground surface (5 to 6 ft. below lake level) and the necessity for a water-surface elevation of 22.5 ft. above the lake level, this plan required supporting the entire structure on piles or on hydraulically-placed and confined sand fill, or the construction of excessively deep basins. In order to decrease the expense, and to secure the desired water level in the coagulating basins, without excessive depth, the two-story type of construction was adopted."

It would seem, therefore, that the controlling factors leading to the adoption of double-deck settling basins at the three large water filtration plants using them include: Topographic conditions, the hydraulics of the system, the shape and size of the basins, the depth of the water required for efficient operation and the economics of the structural design.

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## Slide Rule Devised For Water Calculations

A water technologist's special slide rule has been devised to solve directly the following type problems: comparison of the equivalent concentrations of the commonly occurring ions, calculation of hardness from ionic analysis, summation of total milli-equivalent concentration, balancing ions for determining sodium by difference, chemical dosage for treatments with lime and soda ash.

The new rule was described by A. Adler Hirsch, State Department of Education, Baton Rouge, La., in a paper at the recent American Chemical Society meeting.

# FROM FIELD AND OFFICE

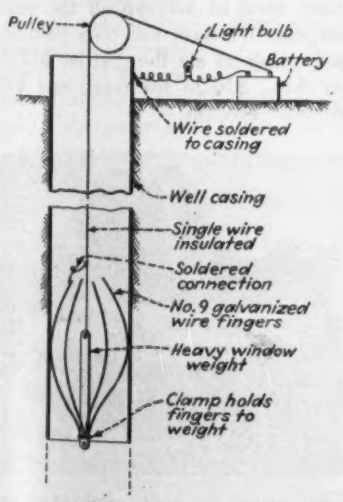
*Working problems and time-saving methods . . . Edited by Charles S. Hill*

## Well Casing Depth Detector

HANFORD THAYER
Superintendent of Construction,
U. S. Bureau of Fisheries, Seattle

A simple and inexpensive device for measuring depth of casing in wells, developed by Ralph H. Olson, Las Vegas, Nev., operates as indicated in the accompanying sketch. The equipment required includes an automobile battery and 6-volt bulb, some No. 9 galvanized wire for contact fingers and enough insulated wire to support a window weight while it is lowered as far down as the casing goes. No. 9 galvanized wire has the right amount of spring to complete the circuit. To avoid risk of fouling, the fingers should be long enough to make gradual bends and their ends should be brought to the center. Window weights, which are made of a very poor grade of cast iron and hence break up easily under a drill, should always be used. If such a weight be lost in the well, it will not interfere with later drilling operations as would a steel weight.

Electrical connections should be soldered. When the wire fingers make contact with the casing, the circuit is complete and the bulb lights. The light grows dimmer as the resistance increases; when the fingers are lowered below the bottom of the casing, breaking the circuit, the light goes out. At this point, the wire is marked at the top of the casing, withdrawn and measured. The device has been used successfully in a well more than 800 ft. deep.




Device for measuring the depth of steel casing in a drilled hole or well.

• • •

## Brackets Aid Pipeline Servicing

ELTON STERRETT
Longview, Tex.

By welding a series of brackets 3 ft. below the saddles of a series of A-frames designed to carry a cast-iron water main across a swale, which was at times severely scoured by flash floods, the servicing of the pipe after installation was simplified and the only additional equipment required was a pair of planks long enough to span the gap between alternate frames. These brackets were set nearly perpendicular to the frame instead of being levelled, so as to eliminate the need for a retainer at the outer end. They are at the right height to permit inspection of the line, painting, caulking and other servicing operations.

Brackets welded onto the A-frames provide for quick placing of scaffold for servicing, inspection or painting water line subject to flooding.

CAMERA MEMORANDA

In forcing pipe through a railway fill at Des Moines, Iowa, these plates welded into the end of the lead pipe were found useful in controlling the inflow of sand to prevent inrushes and caving.

• • •

## Practices from a City Waterworks

L. A. SMITH
Superintendent, Water Department,
Madison, Wis.

1. The permanent record of the supply and distribution system is kept on cloth-backed paper, 18 x 24 in. in size. This shows the location of every service, hydrant, valve, and also the location and size of all mains in the distribution system. Photostatic copies of these sets are made and bound in books so that every foreman and the chief engineer has access to the complete records at all times for use in case of emergency. One of these books is carried by every service crew.

2. In the location of leaks, in addition to the meter inspectors reporting leakage which they discover when they hear water running and there is no use of water in the house, it is found that many service leaks show up by bare spots in the pavement after a light snow. Investigation of these bare spots quite often shows that they are caused by leaks.

3. The city has had a very excellent WPA survey of all of the services in the city. Some 18,000 services were located, measured, and the service boxes repaired or brought up to grade if necessary.

4. The clerk of the chief engineer at the pumping station prepares a

WATER DEPARTMENT Pumping Station City of Madison, Wis. DAILY PUMPAGE—COSTS EFFICIENCY + 35,358,000 Date MAR 11 1940 19

| Station | Pumpage | Cost 1000 lbs. Steam | Boiler Evap. | Pumpage Per Lb. Net Comb. | Pumpage Per K. W. Hr. | Cost Per Mil. Gals. |
|---|---|---|---|---|---|---|
| Main Station Steam | 5,290,000 | 45¢ | 3.14 | 29.5 | — | 22.80 |
| Unit Well No. 1 | | — | — | — | | $ |
| Unit Well No. 2 | | — | — | — | | $ |
| Unit Well No. 3 | | — | — | — | | $ |
| Unit Well No. 4 | | — | — | — | | $ |
| Unit Well No. 5 | | — | — | — | | $ |
| Unit Well No. 6 | 2,822,000 | — | — | — | 727 | $17.00 |
| Unit Well No. 7 | | — | — | — | | $ |
| Total All Elec. Stations | 2,822,000 | — | — | — | 727 | $25.20 |
| Total All Stations | 8,112,000 | — | — | — | — | $23.60 |
| Av. For Year '40 | 7,849,000 | — | — | — | — | $26.15 |
| Av. Last Year 39 | 7,351,000 | — | — | — | — | $27.79 |

**Daily report card on pumping operations at the Madison, Wis., waterworks provides up-to-the-minute data on costs.**

daily report of pumpage and costs by nine o'clock on the next day. This gives such items as the cost per 1,000 lb. of steam, boiler evaporation and items of that kind, as well as the total cost of pumpage per million gallons for the year up to date and the cost per million gallons in the previous year up to date. One of these cards is illustrated.

5. For several years the city has had men on duty from 5 p.m. to 1 a.m. every night including Sundays. These men are located at the service building and work on a 40-hr. week basis so that during three nights each week two men are on duty at the same time. In addition to answering all calls for service of any kind, they wash and grease the trucks and check the tires. Inasmuch as the department has a dozen units in service, this materially decreases all costs of truck maintenance and the work is done at such time as not to take the trucks out of service.

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## Valve-Operating Truck

J. C. DETWEILER
Construction Engineer,
Metropolitan Utilities District,
Omaha, Neb.

Valve-operating trucks are not unique but the illustration shows one that we call a "lawn mule" which is a very handy piece of equipment to have around any place where there are small maintenance jobs and valve operations. This unit consists of a short-coupled Ford Model-A chassis with a small hand-dump body on the rear. The valve-operating equipment

**Combined valve-operating and dump truck for general waterworks plant service.**

shown on the side of the machine is one of the most usable pieces of equipment around the plant. We have three similar valve-closing machines on regular-service trucks operating throughout the city. They are constructed from automobile parts. It is the intention that the unit illustrated shall stay on the station grounds and always be available for plant operations. The general use consists of serving maintenance crews, pulling gang mowers and operating valves on the station grounds.

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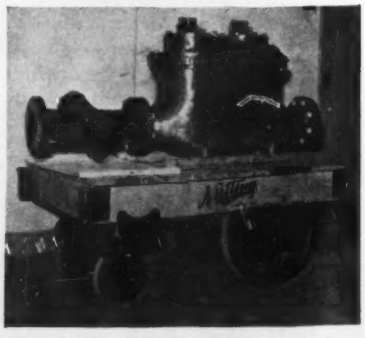
## Diagonal Specials for Meters

D. D. GROSS
Chief Engineer, Board of Water Commissioners, Denver, Colo.

Since 1907 diagonal-flange specials have been used to facilitate the installation of 4, 6 and 8-in. meters in water services in Denver, Colo. This device was thought out by J. C. Sweeney, City Superintendent. It consists of a two piece flanged casting about 19 in. long in the case of a 6-in. special, with a diagonal flange placed at an angle of 30 deg. to the vertical, midway between the two face flanges. The complete assembly, attached to a meter, is shown in the photograph below.

The diagonal special may be connected either to the inlet or outlet side of the meter, and if a flanged valve is used in the meter setting it is conveniently placed between the valve and the meter. When it becomes necessary to remove the meter from the setting for testing, repairs or any other purpose, both its removal and installation are easily accomplished by removing the bolts on the diagonal flange and one of the face flanges, and lifting out one segment of the diagonal special.

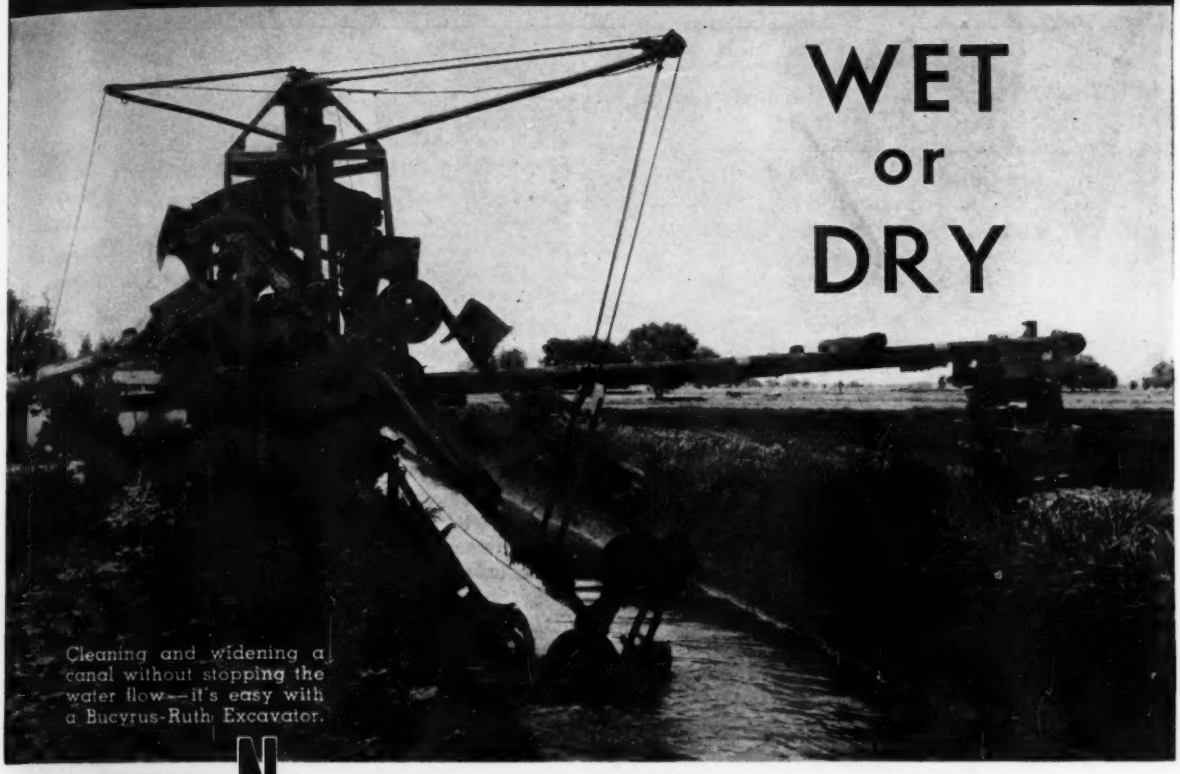
The diagonal special is less expensive than the expansion joints sometimes used to accomplish the same purpose. We have our own patterns, and in lots of six the cost is: $13.50 for 4-in., $16.25 for 6-in., and $18 for 8-in. specials.



**Larger meters are easily removed or replaced when diagonal specials are used in the meter setting.**

# CLEAN YOUR DITCHES

## WET or DRY



Cleaning and widening a canal without stopping the water flow—it's easy with a Bucyrus-Ruth Excavator.

No longer need your district interrupt water service to clean ditches. With the Bucyrus-Ruth Excavator you clean wet ditches just the same as dry ones. With water in the ditch, the Bucyrus-Ruth moves along the bank just the same . . . leaves the same smooth, uniform slopes and bottom. It is not necessary for the operator to see the bottom of the ditch to do a good job. Silt, sand, clay, gumbo, loam, gravel, rank growths and even willows can be handled with the excavator. Big, wide tracks keep you on top of soft ditch banks . . . you move as you dig, thus the machine has little chance to settle.

Many irrigation, drainage and reclamation districts . . . the world over . . . use Bucyrus-Erie draglines and tractor equipment for construction and maintenance work. Ask for details.

BUCYRUS ERIE

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SOUTH MILWAUKEE, WISCONSIN

# CONTRACT UNIT PRICES

*What contractors are bidding on different kinds of construction work*

## TUNNEL APPROACHES NEW YORK

**OWNER:** New York City Tunnel Authority, A. B. Jones, chairman; Ole Singstad, chief engineer.

**PROJECT:** Manhattan surface approach construction consisting of roadways, walls, and incidental structures for entrances and exits of Manhattan plazas of Queens-Midtown Tunnel. Entrance approaches located between First and Second Aves., extending from E. 34 to E. 36 Sts., and from E. 37 to E. 40 Sts. Exits between Second and Third Aves., extending from E. 34 to E. 35, and from E. 37 to E. 41 Sts.

**CONDITIONS:** All materials to be furnished by contractor and project must be completed in six months. Rail, highway and water transportation facilities available. Wage rates specified are: skilled, $1.40 to $2.12½ per hr.; semi-skilled, 87½c. to $1.25; and common labor, 87½c. per hr.

**BIDS:** Eleven bids were opened February 27, 1940, ranging from the contract low of $240,015 to $308,920.

**LOW BIDDERS:**

1. Del Balso Constr. Corp., New York, N. Y... $240,015
2. Reiss & Weinsier, Inc., Brooklyn, N. Y..... 246,964
3. Skolnick Building Corp., New York, N. Y... 249,358

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Earth excav., surf. approach struct. | 6,900 c. y. | $0.75 | $1.50 | $1.00 |
| 2. Remove sheet asph. pavement | 800 s. y. | .20 | .18 | 1.00 |
| 3. Remove granite block pavement | 1,950 s. y. | .25 | .22 | 1.00 |
| 4. Remove pavement base, and add'l. excavation below base | 500 c. y. | 1.00 | 1.40 | 1.50 |
| 5. Remove existing curbs | 1,650 l. f. | .10 | .22 | .30 |
| 6. Remove sidewalk; excavation | 1,000 c. y. | .75 | 2.25 | 2.00 |
| 7. Trench excavation | 800 c. y. | 2.50 | 2.90 | 4.00 |
| 8. Rock excavation; disposal | 100 c. y. | 6.00 | 5.50 | 12.00 |
| 9. Trench excavation in rock | 140 c. y. | 7.00 | 9.00 | 15.00 |
| 10. Fill | 5,800 c. y. | .25 | .55 | .50 |
| 11. Additional fill | 130 c. y. | 3.50 | 4.40 | 4.00 |
| 12. Cement used in conc. | 5,800 bbl. | 2.20 | 2.40 | 2.40 |
| 13. Conc. base, surf. appr. pavement | 1,600 c. y. | 6.00 | 5.50 | 6.50 |
| 14. 5-in. conc. sidewalks, incl. cinder fill. | 830 s. y. | 2.00 | 2.05 | 2.75 |
| 15. 11-in. conc. sidewalks, cinder fill | 60 s. y. | 2.50 | 3.00 | 5.00 |
| 16. All other concrete | 2,250 c. y. | 14.00 | 9.50 | 14.00 |
| 17. Brick and granite masonry, surf. approach walls | L.S. | 65,500.00 | 74,600.00 | 63,405.00 |
| 18. Brick masonry | 130 c. y. | 30.00 | 29.00 | 25.00 |
| 19. Misc. galv. steel | 500 lb. | .10 | .25 | .15 |
| 20. Miscellaneous steel | 11,000 lb. | .07 | .17 | .06 |
| 21. Reinforcing bars | 80 ton | 100.00 | 100.00 | 100.00 |
| 22. Cast-iron castings | 12 ton | 120.00 | 160.00 | 135.00 |
| 23. Cast-steel castings | 8 ton | 350.00 | 450.00 | 440.00 |
| 24. Dampproofing | 780 s. y. | .30 | .30 | .27 |
| 25. Asphalt water stops | 330 l. f. | .10 | .17 | .20 |
| 26. Sheet copper water stops | 1,500 s. f. | .50 | .55 | .50 |
| 27. 3½-in. 4-way vit. clay ducts, incl. envelope | 7,200 duct f. | .30 | .75 | .33 |
| 28. 12-in. vit. pipe conn. and cradles | 440 l. f. | 2.00 | 3.00 | 1.00 |
| 29. 4-in. cast iron pipe drains | 30 l. f. | 2.00 | 1.60 | 2.50 |
| 30. 6-in. c. i. pipe conn., incl. cradles | 150 l. f. | 3.00 | 2.40 | 3.00 |
| 31. 12-in. c. i. pipe conn., incl. cradles | 140 l. f. | 6.00 | 5.30 | 3.50 |
| 32. Plastering, receiving basins | 700 s. y. | 1.00 | 1.00 | 1.20 |
| 33. 2-in. galv. steel conduit | 1,800 l. f. | .65 | .75 | .67 |
| 34. 2-in. galv. steel conduit, incl. envel. | 300 l. f. | .85 | 1.25 | .65 |
| 35. 2½-in. galv. steel conduit, incl. envel. | 2,300 l. f. | 1.10 | 1.10 | .80 |
| 36. Lighting standards, mercur. vapor | 15 ea. | 350.00 | 440.00 | 356.00 |
| 37. Lighting standards, sodium vapor | 15 ea. | 425.00 | 500.00 | 428.00 |
| 38. Lighting standards, incandescent | 11 ea. | 300.00 | 390.00 | 280.00 |
| 39. Wrought iron gates | 6 ea. | 150.00 | 110.00 | 70.00 |
| 40. Chain link fence, on foundations | 500 l. f. | 3.00 | 3.00 | 2.90 |
| 41. Chain link fence, conc. walls | 400 l. f. | 3.00 | 3.00 | 2.90 |
| 42. Sheet asph. pavemt., excl. conc. base | 10,200 s. y. | 1.35 | 1.05 | 1.30 |
| 43. Relay granite pav. block | 1,300 s. y. | 1.50 | 2.10 | 2.00 |
| 44. Conc. base, within areas of exist. streets | 700 c. y. | 6.00 | 8.50 | 7.50 |
| 45. New conc. sidewalks, incl. fndn. | 500 s. y. | 2.00 | 2.20 | 2.25 |
| 46. Colprovia sidewalk, incl. fndn | 40 s. y. | 1.50 | 3.50 | 1.75 |
| 47. Conc. paving, driveways; incl fndn. | 100 s. y. | 2.00 | 3.00 | 2.50 |
| 48. Bitum. yard pavmt.; cinder fndn | 1,300 s. y. | 1.35 | 2.10 | 1.95 |
| 49. Conc. curbs; steel protectors | 700 l. f. | 2.00 | 2.25 | 3.00 |
| 50. Granite headers, with cradles | 330 l. f. | 1.50 | 2.50 | 2.00 |
| 51. Reset granite curbs, new cradles | 220 l. f. | 1.25 | 2.00 | 1.50 |
| 52. Reset bluestone curb, new cradles | 470 l. f. | 1.25 | 1.50 | 1.20 |
| 53. Change location of fire hydrants | 2 ea. | 150.00 | 110.00 | 40.00 |
| 54. Furn. 1½-in. galv. steel conduit | 150 l. f. | .25 | .70 | .25 |
| 55. Lay 1½-in. galv. steel conduit | 309 l. f. | .50 | .70 | .45 |
| 56. Furn. 1½-in. cem. lined steel water pipe | 55 l. f. | .50 | 1.20 | 1.00 |
| 57. Lay 1½-in. cem. lined steel water pipe | 110 l. f. | 2.00 | .80 | .75 |
| 58. Underpinning, 311 E. 37 St | L.S. | 500.00 | 1,500.00 | 1,500.00 |
| 59. Underpinning, 317 E. 37 St | L.S. | 500.00 | 1,000.00 | 2,000.00 |
| 60. Demolition of 19 structures | L.S. | 27,785.00 | 13,950.00 | 22,900.00 |
| 61. Steel curb protectors | 4,000 l. f. | 1.25 | 1.15 | 1.25 |
| 62. ½-in. pre-molded cork joint filler | 650 s. f. | .35 | .33 | .25 |
| 63. ½-in. pre-molded cork joint filler | 300 s. f. | .45 | .42 | .35 |

## HIGHWAYS, RHODE ISLAND

**OWNER:** Division of Roads and Bridges, Department of Public Works, Rhode Island and Providence Plantations.

**PROJECT:** Construction of state roads in town of Jamestown. Involves paving of Narragansett Avenue from Canonicus Avenue to North Road with 6-in. bituminous macadam, 34-ft. wide; and North Road from Round Swamp to Eldred Avenue with 8-in. bituminous macadam, 20-ft. wide.

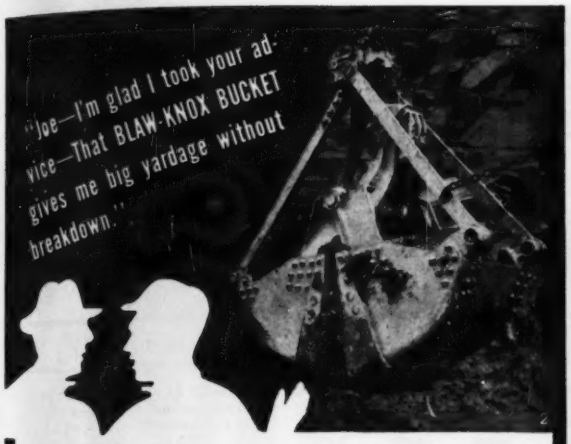
**CONDITIONS:** All materials such as gravel for foundation, crushed stone for pavement, etc., has to be delivered by ferry or barge as there are no suitable roadbuilding materials on island of Jamestown. Contractor to furnish all materials and complete entire project by June 30, 1940. Minimum wage rates are: skilled labor, 75c. per hr.; semi-skilled, 60c.; and common labor, 50c. per hr.

**BIDS:** Six bids were opened January 9, 1940, ranging from the contract low of $99,098 to $130,346.

**LOW BIDDERS:**

1. Callan Constr. Co., Briston, R. I. (contract).. $99,098
2. M. A. Gammino Constr. Co., Providence, R. I. 100,000
3. P. Romano & Son, Warren, R. I..... 101,962

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Clear and grub | 4.37 ac. | $50.00 | $50.00 | $80.00 |
| 2. Cut and remove trees | 1 ea. | 50.00 | 50.00 | 15.00 |
| 3. Earth excavation | 10,635 c. y. | .33 | .25 | .50 |
| 4. Marsh excavation | 2,096 c. y. | .25 | .30 | .40 |
| 5. Trench earth excav | 543 c. y. | .60 | 1.00 | .90 |
| 6. Rock or ledge excav | 150 c. y. | 2.00 | 2.00 | 2.00 |
| 7. Trench ledge excav | 233 c. y. | 3.00 | 3.00 | 2.50 |
| 8. Remove, dispose exist. pave | 922 s. y. | .20 | .25 | .35 |
| 9. Scarify, reshape exist. pave | 4,431 s. y. | .10 | .25 | .15 |
| 10 Trim and fine grade | 56,462 s. y. | .02 | .03 | .03 |
| 11. Strip and pile loam | 1,580 c. y. | .35 | .40 | .50 |
| 12. Replace loam | 1,580 c. y. | .40 | .40 | .60 |
| 13. Furn. and place loam | 866 c. y. | 1.00 | 1.00 | 1.00 |
| 14. Gravel foundation, type A | 16,638 c. y. | 1.40 | 1.65 | 1.49 |
| 15. Cr. stone or gravel base | 6,366 ton | 2.38 | 2.25 | 2.30 |
| 16. Filler for base, (sand) | 1,626 c. y. | 1.40 | .75 | 1.55 |
| 17. Cr. stone top for B. M | 5,251 ton | 3.20 | 2.85 | 2.84 |
| 18. Bitum. binder (CA-3) | 72,933 gal. | .085 | .10 | .085 |
| 19. Bitum. material, RF, T-2 | 7,730 gal. | .12 | .15 | .13 |
| 20. 12-in. Class A pipe, rein. conc | 546 l. f. | 1.30 | 1.15 | 1.21 |
| 21. 18-in. Class A pipe, rein. conc | 118 l. f. | 2.10 | 2.00 | 2.13 |
| 22. 24-in. Class A pipe, rein. conc | 44 l. f. | 3.00 | 3.00 | 3.20 |
| 23. 18x12-in. T-conn., rein. conc | 2 ea. | 15.00 | 15.00 | 16.00 |
| 24. 12-in. copper steel pipe, Cl. B | 793 l. f. | .80 | .65 | .68 |
| 25. 18-in. copper steel pipe, Cl. B | 24 l. f. | 1.50 | 1.45 | 1.60 |
| 26. 24-in. copper steel pipe, Cl. B | 74 l. f. | 2.50 | 2.50 | 2.73 |
| 27. 30-in. copper steel pipe, Cl. B | 20 l. f. | 4.50 | 3.75 | 4.60 |
| 28. Asph. coated corr. met. pipe | 54 l. f. | 1.50 | 1.35 | 1.50 |
| 29. Remove, relay 12-in. corr. met. pipe | 74 l. f. | .50 | .30 | .40 |
| 30. Drop inlets | 5 ea. | 60.00 | 60.00 | 59.00 |
| 31. Reconstr. catch basins | 2 ea. | 50.00 | 40.00 | 50.00 |
| 32. Reconstruct manholes | 4 ea. | 50.00 | 30.00 | 20.00 |
| 33. Catch basin, type D | 17 ea. | 25.00 | 40.00 | 44.00 |
| 34. Catch basin, type E | 2 ea. | 30.00 | 45.00 | 47.00 |
| 35. Catch basin, type G | 1 ea. | 30.00 | 48.75 | 45.00 |
| 36. 8-in. vertical wall | 120 v. l. f. | 10.00 | 10.00 | 10.00 |
| 37. Remove, backfill catch basins | 4 ea. | 25.00 | 2.00 | 10.00 |
| 38. Cement concrete masonry | 28 c. y. | 18.00 | 20.00 | 19.00 |
| 39. Reinforcing steel | 465 lb. | .06 | .10 | .05 |
| 40. Remove, rebuild stone walls | 2,265 l. f. | .60 | .60 | .50 |
| 41. Cement concrete edging | 470 l. f. | .65 | .60 | .72 |
| 42. Precast conc. curb (std. str.) | 3,470 l. f. | 1.20 | 1.13 | 1.28 |
| 43. Precast conc. curb. (std. cir.) | 291 l. f. | 1.40 | 1.35 | 1.44 |
| 44. Precast conc. curb (std. 2-ft. c.) | 40 ea. | 4.50 | 5.00 | 5.00 |
| 45. Precast conc. curb ("8" str.) | 205 l. f. | 1.20 | 1.20 | 1.37 |
| 46. Precast conc. curb ("8" cir.) | 56 l. f. | 1.35 | 1.35 | 1.45 |
| 47. Granolithic walks, found | 2,737 s. y. | 2.30 | 2.25 | 2.00 |
| 48. Rein. cem. conc. driveways | 40 c. y. | 15.00 | 15.00 | 13.00 |
| 49. Riprap, hand laid | 160 s. y. | 1.50 | 1.50 | 1.70 |
| 50. Grouted cobble gutter | 1,648 s. y. | 1.75 | 1.25 | 1.80 |
| 51. Guard rail, wooden, type N | 1,721 l. f. | .50 | .40 | .42 |
| 52. Bitum. mat'l. (RT, T-2-4) | 8,793 gal. | .14 | .15 | .16 |
| 53. Seeding, park areas | 2,017 s. y. | .05 | .03 | .09 |
| 54. Seeding, slope areas | 13,533 s. y. | .05 | .03 | .09 |
| 55. Seed, park mix A | 63 lb. | .40 | .60 | .25 |
| 56. Seed, slope mix A | 420 lb. | .35 | .50 | .25 |
| 57. Fertilizer (8-8-4) | 3,501 lb. | .05 | .03 | .04 |

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If you aim to increase yardage and efficiency, to reduce maintenance costs and prolong the life of your buckets—investigate Blaw-Knox Buckets for all kinds of digging and rehandling. Send for Blaw-Knox Bulletin No. 1561.

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FARMER'S BANK BUILDING PITTSBURGH, PENNA.
*Offices and Representatives in Principal Cities*

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*Clamshell* **BUCKETS**

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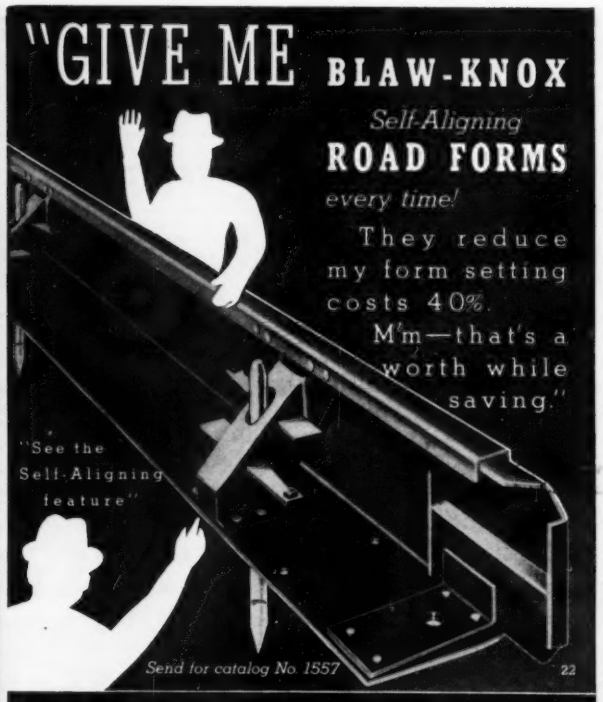
*Self-Aligning*
**ROAD FORMS**
*every time!*
They reduce my form setting costs 40%. M'm—that's a worth while saving."

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*Self Aligning* **ROAD FORMS**

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"YES—AND IT SURE GIVES BIG YARDAGE WORKING ON THAT DRY CONCRETE"

If you're on the fence about buying a road finishing machine this season it will definitely pay you to get full information about this *new* Blaw-Knox ROAD FINISHER.

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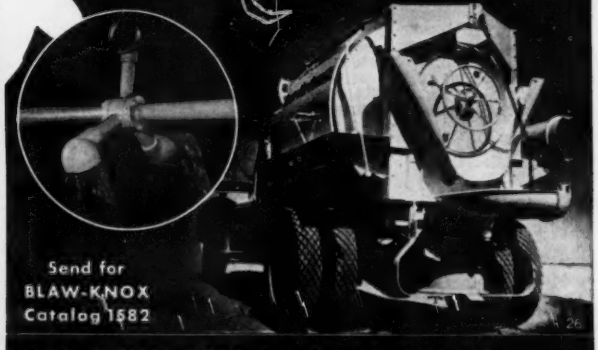
*"MAN... That new WATER IMPELLER in BLAW-KNOX TRUKMIXERS puts water into the batch in one-third the time formerly required."*

The new, fast water impeller that won't clog; an accurate and dependable water measuring system; superb mixing action—and assurance of dependable continuous operation make Blaw-Knox Trukmixers the popular choice, and the practical buy for you. Study these features before you decide.

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*Agitators and* **TRUKMIXERS**

# MATERIALS AND LABOR PRICES

*Market quotations on construction materials and wage rates reported monthly by ENR correspondents*

APRIL construction material prices show only minor changes from last month. Short Leaf Yellow pine is off $1.00 to $2.00 per M ft. bm. in Atlanta; and up $1.00 on the 1-in. sizes in Chicago. Native pine is $4.00 higher on the 2x10-in. size in Denver. Montreal lumber prices are unsteady.

Cement is down 2c. per bbl. in Denver, but up 8c. in Detroit. Sand and gravel are 40c. per ton lower at Pittsburgh. Ready-mixed concrete is down $1.15 per cu. yd. in Montreal and $1.25 in Pittsburgh. Granite paving brick is up $1.50 per M in Pittsburgh, and paving asphalt in drums is $1.20 per ton higher in Detroit.

Common brick is up 50c. per M in New York. Roofing rolls are 5 to 7c. higher in Boston, Cleveland, Minneapolis and New York, and 19c. higher in Atlanta. Ingot aluminum prices drop 1c. per lb. throughout the country. This decrease will be passed along to a number of fabricated products.

Reinforcing steel bars which have been quoted from $1.90 to $2.15 at base are now $1.90 per 100 lb. All other steel prices are unchanged. Vitrified sewer pipe prices are up slightly in both Detroit and Cleveland.

Wage rates for both common and skilled labor remain at March levels in all 20 cities.

## CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

| | PORTLAND CEMENT | | | SAND AND GRAVEL | | | CRUSHED STONE | | CRUSHED SLAG | | CONCRETE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included | | | Per ton, carload lots | | | Per ton, carload lots | | Per ton, carload lots, f.o.b. plant | | Ready Mixed 1:2:4, 50 c.y. or more, delivered |
| | Cloth Bags | Paper Bags | Bulk | Gravel, 1½ in. | Gravel, ¾ in. | Sand | 1½ in. | ¾ in. | 1½ in. | ¾ in. | |
| Atlanta | $2.90 | $2.65 | .... | $1.75 | $1.85 | $1.95 | $1.65 | $1.75 | $1.55 | $1.65 | $7.90 |
| Baltimore | 2.31 | 2.06 | 1.86 | 1.70‡ | 1.70‡ | 1.20‡ | 1.75‡ | 1.75‡ | 1.75‡ | 1.75‡ | 6.50 |
| Birmingham | 2.50 | 2.25 | 2.05 | 1.90 | 1.80 | 1.50 | 1.00 | 1.00 | .90 | 1.15 | 5.80 |
| Boston | 2.75*b* | 2.50*b* | 2.30 | 1.10‡ | 1.10‡ | .80‡ | 1.10‡ | 1.10‡ | .... | .... | 6.75*m* |
| Chicago | 2.60 | 2.35 | 2.20 | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 1.25‡ | 1.25‡ | .... |
| Cincinnati | 2.58 | 2.33 | 2.08 | 1.20 | 1.20 | 1.10 | 1.80 | 1.80 | .... | .... | 6.60 |
| Cleveland | 2.29 | 2.04 | .... | 1.45*i* | 1.45*i* | 1.45*i* | 1.70*i* | 1.70*i* | 1.70*i* | 1.70*i* | 6.85*i* |
| Dallas | 2.30 | 2.05 | 1.85 | 2.00*p* | 2.00*p* | 1.50*p* | 1.69*p* | 1.84*p* | .... | .... | 6.20 |
| Denver | 3.00 | 2.75 | .... | 1.20 | 1.40 | .90 | .... | .... | .... | .... | 7.25 |
| Detroit | 2.23 | 1.98 | 1.78 | 1.30 | 1.40 | .80 | 1.30 | 1.45 | 1.02‡ | 1.14‡ | 6.50 |
| Kansas City | 2.56 | 2.31 | 2.16 | 1.85 | 2.30 | 1.00 | 1.91 | 1.91 | .... | .... | 7.90*n* |
| Los Angeles | 2.82*b* | 2.62*b* | .... | 1.00 | 1.00 | 1.00 | 1.00*f* | 1.00*f* | .... | .... | 5.85 |
| Minneapolis | 3.00 | 2.75 | .... | 1.00*h* | 1.00*h* | .25*h* | 1.00*h* | 1.00*h* | .... | .... | 7.60*j* |
| Montreal | .... | 1.75*r* | 1.60*r* | .... | .... | 1.25‡ | .85‡*c* | 1.00‡*c* | .... | .... | 6.45*i* |
| New Orleans | 2.41 | 2.16 | 1.96 | 1.50 | 1.50 | 1.25 | .... | .... | .... | .... | 7.25 |
| New York | 2.60‡ | 2.35‡ | .... | 1.40*de* | 1.40*de* | .90*de* | 1.65*de* | 1.75*de* | .... | .... | 7.25 |
| Philadelphia | 2.32 | 2.07 | 1.87 | 1.55‡ | 1.65‡ | 1.25‡ | .... | .... | 1.00 | 1.00 | 7.95*k* |
| Pittsburgh | 2.44 | 2.19 | 1.99 | 1.40‡ | 1.40‡ | 1.70‡ | 2.25‡ | 2.25‡ | 1.50 | 1.50 | 7.50 |
| St. Louis | 2.55 | 2.30 | .... | 1.50‡ | 1.50‡ | 1.25/1.50‡ | .85*h* | .85*h* | .75*g* | .75*g* | 7.50 |
| San Francisco | 2.72 | 2.52 | 2.20 | 1.36 | 1.36 | 1.36 | 1.46 | 1.46 | .... | .... | 7.63 |
| Seattle | 2.95*c* | 2.70*c* | .... | 1.00*c* | 1.00*c* | 1.00*c* | 2.00*c* | 2.00*c* | .... | .... | 7.25 |

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

**CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL**

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

| | Bagged | Bulk | | Bagged | Bulk | | Bagged | Bulk |
|---|---|---|---|---|---|---|---|---|
| Buffington, Ind | $1.70 | $1.65 | Ironton, Ohio | $1.60 | $1.55 | Richard City, Tenn | $1.80 | $1.75 |
| Dallas, Tex. (Inc. 5c. tax) | 1.80 | 1.75 | Limedale, Ind | 1.70 | 1.65 | Steelton, Minn | 1.80 | 1.75 |
| Hannibal, Mo | 1.70 | 1.65 | Norfolk, Va | 1.65 | 1.60 | Universal, Pa | 1.65 | 1.60 |
| Hudson, N. Y | 1.75 | 1.70 | Northampton, Pa | 1.55 | 1.50 | Waco, Tex. (5c. Tax inTex.) | 1.75 | 1.70 |
| Independence, Kans | 1.70 | 1.65 | North Birmingham, Ala | 1.70 | 1.65 | Montreal | 1.55 | 1.53 |

## PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

| | PAVING BRICKS AND BLOCKS | | | PAVING ASPHALT | | ASPHALT BINDERS—FLUXES | | CUTBACK ASPHALT | | ROAD OILS | ASPHALT EMULSION (Quick-breaking) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Granite per M. lots of 50,000 4x4x8 in. | Brick per M. 3x4x8½ in. carload lots | Wood per sq. yd. 3½ in. 16-lb. treat | Per ton, less than 80 penetration | | Per gal. 80-300 penetration | | Per ton | | Per gal. | Per gal. | |
| | | | | Tank car | Drums | Tank car | Drums | Tank car | Drums | Tank car | Tank car | Drums |
| Atlanta | $73.00 | $39.35 | $2.25 | $16.60*e* | $22.83*e* | $0.0645*e* | $0.1165*e* | $0.0684*he* | $0.1207*h* | $0.0634*e* | $0.0644 | $0.0684 |
| Baltimore | 145.00‡ | 44.00‡ | 2.75 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | ..... | ..... | ..... |
| Birmingham | ..... | 28.50*j*‡ | ..... | 19.20 | 25.20 | .0797 | .1097 | .0834*h* | .1334*h* | ..... | ..... | ..... |
| Boston | 90.00 | 46.50 | 3.25 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | ..... | .09‡ | .12‡ |
| Chicago | 140.00 | 49.00 | 1.80*d* | 14.00 | 18.00 | 13.00*g* | 17.00*g* | .06*h* | .10*h* | .035 | .08 | .12 |
| Cincinnati | 112.00 | 37.50 | ..... | 14.31 | 18.31 | .10 | ..... | 18.00 | ..... | .0525 | ..... | .08 |
| Cleveland | 110.00 | 37.50 | 2.80 | 15.25 | 20.50 | .07 | .08 | .07*h* | .085*h* | .035 | .08 | .09 |
| Dallas | ..... | 30.00 | ..... | 13.25 | 20.30 | .06 | .103 | 15.00 | 24.80 | .055 | .05/.07 | .07/.09 |
| Denver | ..... | 27.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Detroit | ..... | 35.00 | ..... | 13.60*f* | 19.20*f* | .0678 | .108 | 13.60 | 18.00 | .0545 | .065 | .0924 |
| Kansas City | ..... | 44.00 | ..... | 18.50 | 23.50 | .077 | .1075 | .077*h* | .107*h* | .057 | .11 | .15 |
| Los Angeles | ..... | 50.00 | ..... | 6.50*b* | 15.00 | 6.50*bg* | 15.00*bg* | 5.50*b* | ..... | .0192 | .0525 | .1125 |
| Minneapolis | ..... | ..... | 1.90*d* | 19.20 | 24.20 | .10 | .12 | 19.30 | 28.30 | .056 | ..... | ..... |
| Montreal | 75.00 | ..... | 3.62 | 14.60 | 21.25 | .105 | .1375 | .101*h* | .121*h* | .07 | .135 | .188 |
| New Orleans | ..... | ..... | ..... | 14.00*a* | 19.00*a* | .055 | .085 | .06*h* | .09*h* | ..... | .078 | ..... |
| New York | ..... | ..... | 2.75 | 15.00 | 21.00 | .06 | .09 | .065*h* | .115*h* | ..... | .07 | .11 |
| Philadelphia | 120.00 | 42.50 | 2.84 | 14.00 | 19.00 | .055 | .08 | .06*h* | .09*h* | .05 | .06 | .09 |
| Pittsburgh | 135.00 | 38.75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| St. Louis | 110.00/121.00 | 37.00 | ..... | 14.00 | 19.00 | 14.00*g* | 19.00*g* | .06*h* | .095*h* | .04 | .09 | .125 |
| San Francisco | ..... | 70.00 | ..... | 6.50 | 15.00 | 6.50*g* | 15.00*g* | 7.00 | 17.50 | .025 | .0475 | .117 |
| Seattle | ..... | 60.00*c* | ..... | 13.71 | 23.51 | ..... | 24.11*g* | 10.11/11.11 | 23.61/24.61 | 8.36*g* | .0575*i* | .1308*i* |

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexia. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3½x8½ in.

(Continued on page 112)

# E SURE of these 3 ADVANTAGES

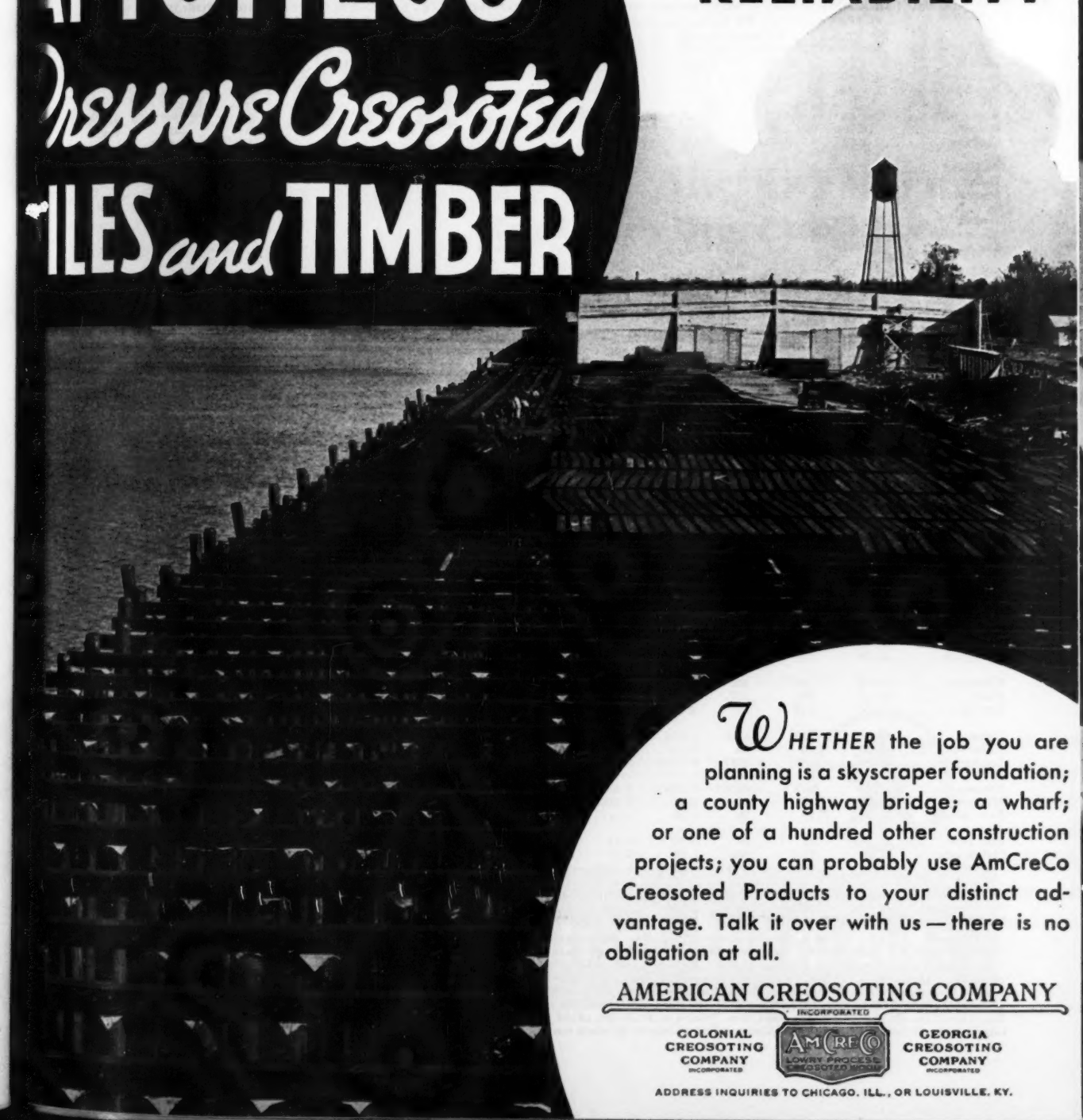
## n your construction materials—

- LONG LIFE
- ECONOMY
- RELIABILITY

# AMCRECO

## Pressure Creosoted

## ILES and TIMBER



WHETHER the job you are planning is a skyscraper foundation; a county highway bridge; a wharf; or one of a hundred other construction projects; you can probably use AmCreCo Creosoted Products to your distinct advantage. Talk it over with us—there is no obligation at all.

AMERICAN CREOSOTING COMPANY

INCORPORATED

COLONIAL CREOSOTING COMPANY INCORPORATED

AMCRECO LOWRY PROCESS CREOSOTED WOOD

GEORGIA CREOSOTING COMPANY INCORPORATED

ADDRESS INQUIRIES TO CHICAGO, ILL., OR LOUISVILLE, KY.

(Continued from page 110)

## IRON AND STEEL PRODUCTS—BASE MILL PRICES

| | STRUCT. SHAPES-PLATE | REINF. BARS ¼-in. billet b | RIVETS ½-in. structural | WIRE NAILS Base d | SHEET PILING Base | STEEL RAILS Per Gross Ton: Standard | Light | Re-rolled | TRACK SUPPLIES: Angle Bars | Std. Spikes c | Tie Plates c | Track Bolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birmingham | $2.10 | $1.90 | $3.40 | $2.55 | .... | $40.00 | $40.00 | $39.00 | $2.70 | $3.00 | $2.15 | $4.15 |
| Chicago | 2.10 | 1.90 | 3.40 | 2.55 | $2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Pittsburgh | 2.10 | 1.90 | 3.40 | 2.55 | 2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Buffalo | 2.10 | 1.90 | .... | .... | 2.40 | .... | .... | .... | .... | .... | 2.15 | .... |
| Cleveland | 2.10 | 1.90 | 3.40 | 2.55 | .... | .... | .... | .... | .... | .... | .... | .... |
| Youngstown | .... | 1.90 | .... | .... | .... | .... | .... | .... | .... | 3.00 | .... | .... |
| Detroit | .... | 2.00‡ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Gulf ports | 2.45a | 2.25a | .... | .... | 2.85a | .... | .... | .... | .... | .... | .... | .... |
| Pacific ports | 2.70a | 2.25a | .... | .... | 2.90a | .... | .... | .... | .... | 3.00 | 2.25 | .... |

‡ Delivered. a F.o.b. cars dock. b Rail steel same as billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l.

## IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

| | STRUCTURAL SHAPES Per 100 lb., base price | REINFORCING BARS* Per 100 lb., ¼ in., base price: 15 tons or over b New billet | Rail steel | Add $/cwt. for Switch | Del. | EXPANDED METAL LATH—Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb. | Std. ribbed 3.4 lb. | WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires | 4x12 in., No. 8 & 12 wires | 6 & 6 wires Per sq. yd. | SHEET PILING Per 100 lb. base price |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $2.34 | $2.39 | $2.39 | .02½ | .10 | $21.00 | $23.00 | $1.82 | $1.35 | $0.1719 | $3.04 |
| Baltimore | 3.60 | 2.85 | 2.70 | ..... | .10 | 21.00 | 23.00 | 1.70 | 1.27 | .1611 | 2.75 |
| Birmingham | 2.10a | 1.90 | 1.90 | .02½ | .10 | 19.50 | 21.50 | 1.80 | 1.34 | .1701 | .... |
| Boston | 3.85 | 2.73 | 2.58 | $20 C.L. | .10 | 21.50 | 23.50 | 1.76 | 1.31 | .1656 | 3.14 |
| Chicago | 2.10a | 1.90 | 1.90 | .03 | .05 | 19.00 | 21.00 | 1.67 | 1.25 | .1575 | 2.40 |
| Cincinnati | 3.68 | 2.51c | 2.51c | ..... | .05 | 20.50 | 22.50 | 1.66 | 1.25 | .1566 | .... |
| Cleveland | 3.58g | 1.90 | 1.90 | .02½ | .10 | 20.50 | 22.50 | 1.66 | 1.25 | .1566 | .... |
| Dallas | 4.75 | 3.25 | 3.25 | ..... | ..... | 25.00 | 27.00 | 1.93 | 1.42 | .1827 | .... |
| Denver | 4.35 | 3.95 | 3.80 | ..... | ..... | 23.50 | 25.50 | 1.97 | 1.45 | .1863 | .... |
| Detroit | 3.60‡ | 2.00 | 2.00 | ..... | .10 | 22.50 | 24.50 | 1.68 | 1.26 | .1584 | 2.66 |
| Kansas City | 4.03 | 2.51c | 2.36c | .0 | .05 | 18.50 | 20.50 | 1.78 | 1.33 | .1683 | 2.86 |
| Los Angeles | 3.65f | 2.55 | 2.40 | .02½ | .05 | 23.00 | 27.50 | 1.93 | 1.42 | .1827 | 3.65 |
| Minneapolis | 3.80‡ | 2.48c | 2.48c | .0 | .10 | 21.50 | 24.50 | 1.80 | 1.34 | .1701 | 2.73d |
| Montreal | 3.90 | 2.70 | 2.60 | ..... | ..... | 26.50 | 29.00 | 2.99 | 2.08 | .319 | .... |
| New Orleans | 4.40 | 2.52 | 2.52 | .05 | .10 | 21.50 | 23.50 | 1.82 | 1.35 | .1719 | 2.875 |
| New York | 3.75 | 2.39 | 2.39 | ..... | .10 | 20.50 | 22.50 | 1.76 | 1.32 | .1665 | 2.74 |
| Philadelphia | 3.55 | 2.66 | 2.56 | ..... | ..... | 19.50 | 21.50 | 1.71 | 1.28 | .1611 | 2.72 |
| Pittsburgh | 2.10a | 1.90 | 1.90 | .02½ | .10 | 21.50 | 24.50 | 1.59 | 1.20 | .1503 | 2.40 |
| St. Louis | 3.47 | 2.39 | 2.39 | .0 | .05 | 24.00 | 28.00 | 1.69 | 1.27 | .1602 | 2.70 |
| San Francisco | 3.35 | 2.525 | 2.375 | .02½ | .10 | 19.00 | 25.50 | 1.93 | 1.42 | .1827 | 3.25 |
| Seattle | 2.70e | 2.25e | ..... | ..... | ..... | 25.50 | 27.50 | 1.93 | 1.42 | .1827 | 2.90e |

‡ Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

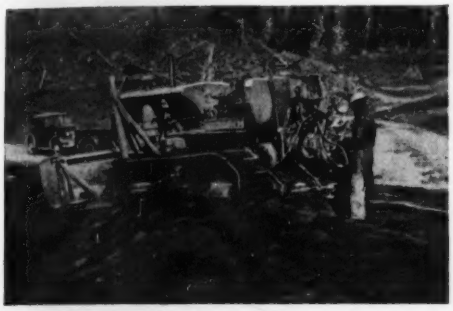
## PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

| | C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a | VITRIFIED SEWER PIPE Per foot, 8 in., s.s. | delivered 12 in., s.s. | ASTM 24 in., d.s. | C13–35 36 in., d.s. | CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in. | f.o.b. 8 in. | CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in. | C 14–35 24 in. | WROUGHT STEEL PIPE Full standard weight, h: 1 to 3 in., Butt Weld Black % | Galv. % | 3½ to 6 in., Lap Weld Black % | Galv. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $49.40 | $0.26bc | $0.468bc | $1.8525 | $4.68c | $85.00 | $128.00 | $0.45 | $1.625 | 62.2 | 54.2 | 59.7 | 51.2 |
| Baltimore | 52.80 | .30 | .55 | 2.30 | 6.80 | 110.00 | 150.00 | .40 | 1.60 | 65.5 | 57.5 | 63.0 | 54.5 |
| Birmingham | 45.00 | .26 | .468 | 1.854 | 4.66 | 85.00 | 220.00 | .40 | 1.60 | 62.2 | 54.2 | 59.7 | 51.2 |
| Boston | 55.00 | .294 | .567 | 2.16 | 6.15 | 199.00‡ | 288.00‡ | .50 | 2.50 | 64.1 | 56.1 | 61.6 | 53.1 |
| Chicago | 53.80 | .28 | .54 | 2.25 | 6.25 | 100.00‡ | 150.00‡ | .38 | 1.48 | 67.0 | 59.0 | 63.5 | 55.0 |
| Cincinnati | 52.70 | .245 | .4995 | 1.9335 | 5.6375 | 105.00 | 170.00 | .60 | 1.70 | 65.9 | 57.9 | 63.4 | 54.9 |
| Cleveland | 54.24 | .224 | .432 | 1.755 | 5.0225 | 69.00 | 108.00 | .35 | 1.50 | 67.8 | 59.8 | 65.3 | 56.8 |
| Dallas | 58.20 | .265 | .477 | 1.728 | 4.70 | 80.00 | 100.00 | .46 | 1.57 | 59.9 | 51.9 | 57.3 | 48.3 |
| Denver | 60.60 | .24† | .52† | 2.16† | ..... | 130.00 | 240.00 | ..... | ..... | 58.4 | 50.4 | 55.7 | 47.2 |
| Detroit | 54.24 | .245 | .4725 | 1.935 | 4.408 | 66.45 | 105.00 | .33 | 1.50 | 66.3 | 58.3 | 63.8 | 55.3 |
| Kansas City | 55.12 | .30 | .54 | 2.16 | 5.00 | 120.00 | 240.00 | .45 | 1.60 | 62.9 | 54.9 | 60.0 | 51.5 |
| Los Angeles | 55.00 | .282† | .508† | 2.034† | 5.065† | 115.50 | 192.50 | 1.00 | 2.00 | 56.8 | 47.8 | 54.3 | 44.8 |
| Minneapolis | 57.20 | .24† | .432† | 1.728† | 4.63† | ..... | ..... | .70 | 1.80 | 64.2 | 56.2 | 60.7 | 52.2 |
| Montreal | 60.00 | .55 | .90 | 3.15 | 5.10e | 135.00‡ | 260.00‡ | .48 | 1.92 | ..... | ..... | ..... | ..... |
| New Orleans | 51.38 | .26 | .48 | 1.69 | ..... | 150.00 | 220.00 | .37 | 2.10 | 62.4 | 54.4 | 58.8 | 50.3 |
| New York | 52.20 | .32 | .63 | 2.52 | 6.45 | ..... | ..... | .50 | 1.20 | 64.9 | 56.8 | 62.4 | 53.9 |
| Philadelphia | 50.90 | .21 | .405 | 1.75 | 5.05 | 100.00 | 160.00 | .54 | 1.80 | 65.3 | 57.3 | 62.8 | 54.3 |
| Pittsburgh | 55.60 | .245† | .4725† | 1.845† | 5.4325 | 97.80 | 154.20 | .85g | 2.00g | 68.5i | 60.5i | 66.0i | 57.5i |
| St. Louis | 52.48 | .24 | .432 | 1.728 | 3.96 | 85.00 | 170.00 | .75j | 1.80k | 65.1 | 57.1 | 62.0 | 53.5 |
| San Francisco | 55.00 | .3275d | .5895d | 2.358 | 5.895 | 107.25 | 178.75 | .45 | 2.50 | ..... | ..... | ..... | ..... |
| Seattle | 55.35 | .35 | .63 | 2.52 | 6.30 | 72.00 | 175.00 | .45f | 1.40f | ..... | ..... | ..... | ..... |

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. j Reinforced; spec. C 75-37. k Reinforced; spec. C 75-37.

(Continued on page 114)

# ANOTHER 100% JOB!



## AND MARFAK DID THIS!

**NOTHING BUT MUD** . . . every day . . . all day. But thanks to Marfak in the track rollers this Caterpillar bulldozer keeps right on the job with no time out for roller troubles.

(*Below*) **WHEEL BEARINGS** and scraper sheaves on this Le Tourneau Scraper are also protected with Marfak. A valuable tip to contractors!

## reports Northwestern Engineering Company

THIS CONTRACTOR had to build a road through a pass 10,000 feet above sea level, out near Dubois, Wyo. Here a tough job was made much tougher by springs and seepage that kept all his equipment working in mud.

To provide a dependable safeguard against time-eating delays and costly mechanical failures he turned to Texaco. Starting with his dragline, every piece of equipment on the job was lubricated with the proper Texaco lubricant.

Today—4 years later, Northwestern Engineering Company's job superintendent says of this Texaco fueled and lubricated job—"excellent results."

More than 2300 warehouses in this country offer you Texaco Lubricants and Texaco Engineering Service. Let us help you better the results you are now getting from your machinery. Prompt deliveries and practical help for the asking.

The Texas Company, 135 E. 42nd St., New York, N. Y.

Texaco Dealers invite you to tune in The Texaco Star Theatre—a full hour of all-star entertainment—Every Wednesday Night—Columbia Network—9:00 E.S.T., 8:00 C.S.T., 7:00 M.S.T., 6:00 P.S.T.

TEXACO

## TEXACO Industrial Lubricants

(Continued from page 112)

## LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

| | SHORT LEAF YELLOW PINE AND DOUGLAS FIR | | | | | | | | LONG LEAF Y. P. | | PLYWOOD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) | | | | | | | | Merchantable grade up to 20 ft. | | Rail freight increment (See note for base price) |
| | *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)* | | | | | | | | | | |
| | 1x6, S4S | 1x8, S4S | 2x4, S4S | 2x6, S4S | 2x8, S4S | 2x10, S4S | 3x12, S4S | 6x12, S4S | 12x12, S4S | 2x12, S4S | 12x12, S4S | 5/16" | 3/4" |
| Atlanta | $19.00 | $19.00 | $18.00 | $19.00 | $19.50 | $20.00 | $26.00 | ..... | ..... | $37.50 | $50.50 | $17.75 | $21.60 |
| Baltimore | 30.00 | 31.50 | 36.50 | 35.50 | 36.00 | 37.00 | 45.00 | ..... | ..... | 68.00 | 68.00 | 17.35*g* | 21.15*g* |
| | *32.00* | *32.00* | *34.00* | *33.00* | *34.00* | *34.00* | *46.00* | *$46.00* | *$49.00* | ..... | ..... | ..... | ..... |
| Birmingham | 22.50 | 23.50 | 22.00 | 21.00 | 22.00 | 23.00 | 37.00 | 36.00 | 36.00 | ..... | ..... | 16.25 | 19.85 |
| [1] | 25.50 | 25.50 | 29.00 | 27.00 | 29.00 | 40.00 | 60.00 | ..... | ..... | 54.00 | 57.00 | ..... | ..... |
| Boston | 32.00[3] | 32.00[3] | 34.00[4] | 34.00 | 53.00[3] | 63.00[3] | 77.00[3] | ..... | ..... | 77.00 | 77.00 | 17.35*g* | 21.15*g* |
| | *29.00* | *29.00* | *34.00* | *34.00* | *36.00* | *36.00* | *45.00* | *45.00* | *60.00* | ..... | ..... | ..... | ..... |
| Chicago | 34.00 | 34.00 | 34.00 | 34.00 | 34.00 | 34.00 | 50.00 | ..... | ..... | 80.00 | 90.00 | 13.15 | 16.05 |
| | *37.00* | *37.00* | *39.00* | *39.00* | *40.00* | *40.00* | *44.00* | *43.00* | *43.00* | ..... | ..... | ..... | ..... |
| Cincinnati | 31.50 | 33.00 | 30.50 | 31.00 | 32.00 | 35.00 | 44.50 | ..... | ..... | 53.00 | 56.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | ..... | ..... | ..... | *46.00* | *46.00* | *48.00* | ..... | ..... | ..... | ..... |
| Cleveland | 32.00 | 32.50 | 33.00 | 33.00 | 36.00 | 38.00 | 45.00 | 46.00 | 46.00 | 80.00 | 80.00 | 16.70 | 20.40 |
| Dallas *e* | 28.50 | 32.00 | 31.50 | 29.00 | 30.50 | 32.50 | 52.50 | 52.50 | 52.50 | 63.50 | 71.00 | 13.90 | 16.95 |
| Denver ‡ | 47.00[4] | 45.00[4] | 42.00[4] | 40.00[4] | 40.00[4] | 45.00[4] | 48.00[4] | 60.00[4] | 71.50[4] | ..... | ..... | 9.90 | 12.05 |
| Detroit | 35.00 | 35.00 | 35.00 | 35.00 | 38.50 | 42.00 | 46.00 | ..... | ..... | 43.50 | 58.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | ..... | ..... | *46.00* | *47.00* | *64.00* | *64.00* | ..... | ..... | ..... | ..... |
| Kansas City | 28.00 | 29.00 | 29.00 | 28.00 | 29.00 | 30.00 | 35.00 | ..... | ..... | 55.00 | 60.00 | 12.25 | 14.95 |
| | *29.00* | *29.00* | *30.00* | *28.50* | *29.00* | *30.00* | *35.00* | *39.00* | *39.00* | ..... | ..... | ..... | ..... |
| Los Angeles *a* | *36.00* | *36.00* | *36.00* | *33.00* | *33.00* | *33.00* | *38.00* | *46.00* | *39.00* | ..... | ..... | 9.35*gh* | 11.35*gh* |
| Minneapolis [2]‡ | 47.00[5] | 47.00[5] | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 12.05 | 14.70 |
| ‡ | *38.00* | *38.00* | *39.00* | *39.00* | *39.00* | *39.00* | *59.00* | *59.00* | *59.00* | ..... | ..... | ..... | ..... |
| Montreal [7] | *34.00* | *36.00* | *32.00* | *34.00* | *36.00* | *42.00* | *45.00* | ..... | ..... | *155.00* | *165.00* | ..... | ..... |
| | *52.50* | *44.50* | *53.25* | *56.25* | *56.25* | *61.25* | *52.00* | *52.00* | *52.00* | ..... | ..... | ..... | ..... |
| New Orleans | 24.00 | 25.00 | 25.00 | 24.00 | 24.00 | 25.00 | 46.00 | ..... | ..... | 62.00 | 69.00 | 13.90 | 16.95 |
| | *29.00* | *29.00* | *32.00* | *33.00* | *35.00* | *34.00* | *36.00* | ..... | ..... | ..... | ..... | ..... | ..... |
| New York ‡ | 38.00 | 39.00 | 37.00 | 38.00 | 38.00 | 39.00 | 42.00 | ..... | ..... | 80.00*f* | 82.50*f* | 17.35*g* | 21.15*g* |
| ‡ | ..... | ..... | *45.00* | *45.00* | *45.00* | *45.00* | *45.00* | *47.50* | *47.50* | ..... | ..... | ..... | ..... |
| Philadelphia | 24.00 | 24.50 | 25.50 | 25.50 | 27.50 | 27.50 | 29.00 | ..... | ..... | 50.00 | 57.50 | 17.35*g* | 21.15*g* |
| | *35.00* | *36.50* | *39.00* | *38.25* | *39.00* | *39.00* | *44.00* | *52.00* | *52.00* | ..... | ..... | ..... | ..... |
| Pittsburgh | 38.10 | 39.90 | 47.05 | 42.00 | 45.65 | 46.90 | 59.70 | ..... | ..... | ..... | ..... | 17.00 | 20.70 |
| | *51.90* | *49.60* | *49.60* | *49.00* | *48.90* | *49.25* | *66.55* | *66.55* | *66.55* | ..... | ..... | ..... | ..... |
| St. Louis ‡*c* | 32.00 | 33.00 | 32.00 | 31.00 | 32.00 | 33.00 | 48.00 | *52.00* | *52.00* | 73.00 | 72.00 | 13.90 | 16.95 |
| San Francisco *d* | *22.50* | *23.00* | *23.00* | *22.50* | *22.00* | *22.50* | *23.50* | *23.50* | *23.50* | ..... | ..... | 7.30*g* | 8.90*g* |
| Seattle | *21.00* | *21.00* | *21.00* | *21.00* | *21.00* | *21.00* | *26.00* | *26.00* | *26.00* | ..... | ..... | 0.00 | 0.00 |

**Bold Face type, Southern Pine.** *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [6] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $77.00; on 3/4", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

## GLASS, EXPLOSIVES, CHEMICALS

| | WINDOW GLASS Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness | | EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots* |
|---|---|---|---|
| | A quality | B quality | |
| Atlanta | 75% | 75% | $0.15 |
| Baltimore | 83% | 82% | .15 |
| Birmingham | 80%*d* | 85%*d* | .105 |
| Boston | 82% | 82% | .15 |
| Chicago | 79% | 79% | .15 |
| Cincinnati | 79% | 79% | .15 |
| Cleveland | 79-10-10% | 79-10-10% | .19 |
| Dallas | 78% | 78% | .165 |
| Denver | 76-10% | 76-10% | .15*e* |
| Detroit | 79-10% | 79-10% | .15 |
| Kansas City | 79-10% | 79-10% | .155 |
| Los Angeles | 86%*d* | 88%*d* | .1575 |
| Minneapolis | 76% | 76% | .155 |
| Montreal | 60-5%*ab* | | .17† |
| New Orleans | 70% | 75% | .16 |
| New York | 82% | 83% | .20*f* |
| Philadelphia | 82-10%*d* | 83-10%*d* | .15 |
| Pittsburgh | 79% | 79% | .1425 |
| St. Louis | 79-10% | 79-10% | .155 |
| San Francisco | 78%*d* | 83%*d* | .155 |
| Seattle | 85%*d* | 88%*d* | .1575 |

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

*a* Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

**40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)**

| | C/L 20,000 lb. net | Tons | 200 lb. lots |
|---|---|---|---|
| E. of the Miss., except Fla. | $0.105 | $0.14 | $0.16 |
| W. of Miss., to Rocky Mtn. States, and Fla | .11 -.12 | .135 -.15 | .155 -.17 |
| Rocky Mtn. States | .11 -.1325 | .13 -.145** | .15 -.165** |
| Pacific N. W. States | .1075-.115 | .1375-.15 | .1575-.17 |
| Pacific S. W. States | .1050-.1175 | .135 -.1475 | .155 -.1625 |

** F.o.b. Louviers, Colo., or Butte, Mont.

## PILES, TIES—F.O.B.

### PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

| Dimensions | Points | Length | Short Leaf Barge | Short Leaf Rail |
|---|---|---|---|---|
| 12 in. at butt | 6 in. | 30 to 50 ft. | $0.18 | $0.195 |
| 12 in.— 2 ft. from butt | 6 in. | 50 to 59 ft. | .225 | .24 |
| 12 in.— 2 ft. from butt | 6 in. | 60 to 69 ft. | .23 | .255 |
| 14 in.— 2 ft. from butt | 6 in. | 50 to 69 ft. | .24 | .265 |
| 14 in.— 2 ft. from butt | 6 in. | 70 to 79 ft. | .28 | .275 |
| 14 in.— 2 ft. from butt | 5 in. | 80 to 85 ft. | .40 | .415 |
| 14 in.— 2 ft. from butt | 5 in. | 85 to 89 ft. | .42 | .482 |

### RAILWAY TIES

| Prices f.o.b., per tie for carload lots: | | 6" x 8" x 8' Untr. | 6" x 8" x 8' Tr. | 7" x 9" x 8'6" Untr. | 7" x 9" x 8'6" Tr. |
|---|---|---|---|---|---|
| Boston | Oak | $1.20 | .... | $1.65 | .... |
| | Pine | 1.50 | $2.25*a* | 2.25 | $3.20*a* |
| New York | S. L. Sap Pine | 1.10/1.20 | 1.85 | 1.50 | 2.35 |
| | Mixed Oak | 1.45 | 1.95 | 1.90 | 2.45 |
| Birmingham | White Oak | .85 | 1.50*a* | 1.35 | 1.70*a* |
| | Southern Pine | .55*b* | 1.10*ab* | .70 | 1.30*a* |
| Chicago | Oak | .... | 1.65*a* | .... | 2.25*a* |
| | Southern Pine | .... | 1.53*a* | .... | 2.13*a* |
| Los Angeles | Douglas Fir | .64 | 1.38*a* | .90 | 1.80*a* |
| Philadelphia | Red Oak | 1.10 | .... | .... | 2.40*a* |
| St. Louis | White Oak | 1.12 | .... | 1.50 | .... |
| | Red Oak | 1.12 | 1.60*a* | 1.50 | 2.03*a* |
| | Sap Pine or Cypress | 1.02 | .... | 1.40 | .... |
| San Francisco | Douglas Fir | .90*bef* | .... | .... | 1.95*ca*/ |
| Montreal | Birch or Maple | .65 | 1.05*a* | .75 | 1.35*a* |

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

### CHEMICALS

**Water, sewage treatment, road work, f.o.b. carlots, New York**

| | |
|---|---|
| Bleaching powder, in drums, f.o.b. works, per 100-lb | $2.00-2.85 |
| Chlorine cylinders, liquid, per lb. delivered | .0525 |
| Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton | 22.00-35.00 |
| Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb | 1.40 |
| Soda ash, 58%, in paper bags, per 100 lb. dense | 1.10 |
| Sulphate of aluminum, commercial, in 100-lb. bags, per ton | 23.00 |
| Sulphate of copper, in bbl., per 100-lb | 4.60 |

(Continued on page 116)

# The Job You Want Done Is *Now* Being Done

with CUMMINS Dependable DIESELS

*for Example* Rhoads Contracting Company work 6 Cummins Diesel-powered trucks in their coal strippings at Ashland, Pa. Over 5 to 10% grades, 13 yard loads are carried on round trip hauls of only one to three miles. Fuel consumption 1.2 gallons per hour . . . less than half the cost of former gas-powered trucks which carried only 6 to 7 yard loads.

Another demonstration of the extra profit you can earn with Cummins Diesel power. Ask for facts and figures on a job you want done. Cummins Engine Company, 3616 Wilson Street, Columbus, Indiana.

(Continued from page 114)

## STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

| | STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in. | 4x12x12 in. | 8x12x12 in. | STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in. | 10x12x12 in. | 12x12x12 in. | BRICK Per M. in quantity, Common backing | Straight hard | LIME Per ton, Hydrated finishing | In paper Common hydrated | Carload lot Pulverized or lump |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $90.00 | $100.00 | $185.00 | $220.00 | $230.00 | $240.00 | $12.50 | $16.00 | $26.50 | $17.00 | $17.00 |
| Baltimore | 74.00 | 80.00 | 165.00 | 190.00 | 240.00 | 290.00 | 13.00[k] | 16.00[k] | 18.50 | 14.50 | 2.50[m] |
| Birmingham | 80.00 | 85.00 | 160.00 | 191.00 | 252.00 | 288.00 | 13.50 | 16.50 | 18.11 | 12.35 | 1.66[o] |
| Boston | 82.10[a] | 87.60[a] | 164.20[a] | 186.10 | 243.20[a] | 277.90[a] | 17.00[i] | 20.00[i] | 19.00 | 12.50 | 3.10[p] |
| Chicago | 68.10 | 72.60 | 135.90 | 185.70 | 234.90 | 268.10 | 11.00 | 12.00 | 16.40 | 14.40 | 12.20 |
| Cincinnati | 61.40 | 65.30 | 121.90 | 141.50 | 187.30 | 215.20 | 16.00 | 16.00 | 15.90 | 13.00 | ..... |
| Cleveland | 56.50 | 60.00 | 112.50 | 135.00 | 182.50 | 209.50 | 16.00 | 16.00 | 15.00[j] | 12.00[j] | 2.75[j][m] |
| Dallas | 62.50 | 67.00 | 135.00 | 162.00 | 177.00 | 263.00 | 11.50[i] | 13.50[i] | 19.00 | 15.00 | .95[n] |
| Denver | 84.80 | 95.40 | 152.70 | 178.20 | 212.00 | 227.90 | 13.50 | 17.00 | 28.00[j] | 17.00[j] | 35.00[j] |
| Detroit | 68.90 | 73.50 | 137.80 | 175.50 | 232.00 | 265.00[e] | 15.70 | 17.00 | 13.50 | 11.75 | 12.75 |
| Kansas City | 64.50 | 66.50 | 86.00[c] | 125.50 | 159.75 | 186.25 | 14.00 | 24.00 | 19.10 | 12.80 | 10.70 |
| Los Angeles | 73.50[†r] | 89.50[†r] | 128.00[c†r] | 210.00[†r] | 368.00[†r] | 460.00[†r] | 13.00 | 15.00 | 16.50 | ..... | 17.50 |
| Minneapolis | 66.70 | 71.20 | 122.50 | 141.30 | 149.30 | 209.40 | 13.10 | 15.10[g] | 21.00 | 16.00 | 19.00 |
| Montreal | 77.20[a] | 77.50[a] | 142.50[a] | 76.00[a] | 165.80[a] | 248.70 | 20.75 | 28.00 | 23.50 | 17.00 | 11.00 |
| New Orleans | 72.00 | 72.00 | 135.00 | 162.00 | 210.00 | 260.00 | 14.00 | ..... | 18.30 | 12.08 | 14.10 |
| New York | 87.00 | 93.00 | 128.00[c] | 193.30[h] | 238.80[h] | 295.60[h] | 15.00 | ..... | 19.00 | 14.00 | 17.50 |
| Philadelphia | 80.50 | 85.90 | 161.10 | 193.30 | 238.80 | 295.60 | 15.00[e] | 18.00[e] | 15.50[q] | 9.55[q] | 12.05[q] |
| Pittsburgh | 58.40 | 62.40 | 116.85 | 124.00 | 153.00 | 193.75 | 17.00 | 25.00 | 17.90 | 15.40 | 2.55[m] |
| St. Louis | 62.00 | 88.00 | 120.00 | 180.00 | 234.00 | 280.00 | 16.00 | 17.00 | 22.00 | 18.00 | 2.30[m] |
| San Francisco | 84.00 | 94.50 | 225.00 | ..... | ..... | ..... | 14.00 | 17.00 | .55[o] | .40[o] | 2.05[m] |
| Seattle | 100.00 | 110.00 | 220.00 | ..... | ..... | ..... | 17.50[f] | 17.50[f] | 20.00[s] | 20.00[s] | 20.00[s] |

† F.o.b. [a] Smooth. [b] Carload lots delivered to job. [c] 6 x 12 x 12 in. [d] Not load bearing. [e] 48 lb. tile. [f] Less $1.00, ½ cash 15 days, balance 30 days. [g] Selected common. [h] F.o.b. Perth Amboy, N. J. [i] 50c per M. off for cash. [j] LCL. [k] $1.00 discount if paid in 10 days. [l] Lump. [m] Per bbl., 180 lb. [n] Per sack 100 lb. [o] Per bbl., 200 lb. [p] 280 lb. bag. [q] 25-ton cars. [r] 5% discount 10 days. [s] 2% off cash. [t] 5½ x 8 x 12.

## PAINT, ROOFING—F.O.B. CARLOAD LOTS

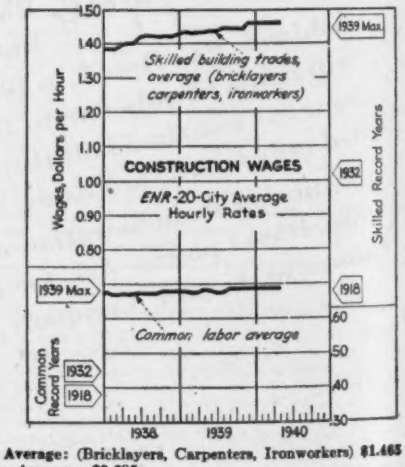
| | RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry [a] | WHITE LEAD Per 100 lb. in oil | READY-MIXED PAINT Per gal., drums Graphite [b] | Aluminum [c] | Ferric Oxide [d] | ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq. | Asphalt felt, per 100 lb. | Tar felt, per 100 lb. | Asphalt coating per gal. | Tar pitch 350 lb. bbl per ton |
|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $8.75 | $13.125 | $1.30 | $2.25 | $1.20 | $1.90 | $1.61 | $1.61 | $0.27 | $29.00 |
| Baltimore | 8.50 | 12.75 | 1.70 | 2.45 | 1.95 | 2.20 | 2.75 | 2.75 | .45 | 27.50 |
| Birmingham | 8.75 | 13.125 | 2.68 | 2.75 | 1.85 | 1.92 | 1.77 | 1.77 | .45 | 27.00 |
| Boston | 8.50 | 12.75 | 1.75‡ | 2.30‡ | 1.75‡ | 1.75‡ | 1.55[h]‡ | 1.85[h]‡ | .47‡ | 20.00‡ |
| Chicago | 8.50 | 12.75 | 1.96 | 2.63 | 1.68 | 1.45[h][f] | 1.53[h][f] | 1.53[h][f] | .26[f] | 21.00[f] |
| Cincinnati | 8.50 | 12.75 | 1.65 | 2.85 | 1.55 | 2.40 | 2.39[h] | 2.39[h] | .36 | 21.00 |
| Cleveland | 8.50 | 12.75 | 1.90 | 2.60 | 1.60 | 1.75 | 1.50[h] | 1.50[h] | .35 | 21.00 |
| Dallas | 8.50 | 13.50 | 1.88 | 2.11 | .... | 2.75[h] | 2.60[h] | 2.70[h] | .275 | 34.00 |
| Denver | 9.00 | 13.25 | 1.65 | 2.40 | .171 | 2.45 | 4.00 | 3.00 | .35 | 18.00 |
| Detroit | 8.00 | 12.75 | 2.00 | 3.00 | 1.75 | 2.40 | 2.75 | 2.75 | .35 | 27.50 |
| Kansas City | 8.50 | 12.875 | 2.15[g] | 2.40[g] | 1.67[g] | 1.93 | 2.09 | 2.09 | .25 | 25.00 |
| Los Angeles | 8.75 | 13.25 | 1.60 | 2.25 | 2.30 | 2.10 | 1.50 | .... | .45 | ... |
| Minneapolis | 8.50 | 12.875 | .... | .... | .... | 1.75[i] | 1.50[h][i] | 1.50[h][i] | .29 | 21.00 |
| Montreal | 9.25 | 9.00 | 2.25 | 2.80 | 2.35 | 2.53 | 1.68 | 1.78 | .70 | 1.68[k] |
| New York | 8.50 | 12.75 | 1.88 | 2.55 | 1.60 | 1.75 | 1.50[h] | 1.50[h] | .23 | 24.00 |
| Philadelphia | 8.50 | 12.75 | .... | .... | .... | 1.92[e] | 1.99[h][e] | 1.99[h][e] | .41[e] | 21.00 |
| Pittsburgh | 8.50 | 12.75 | 1.05 | 1.95 | .80 | 1.95 | 1.94[h] | 1.94[h] | .34 | 26.00 |
| St. Louis | 8.50 | 12.75 | 1.90/2.00 | 2.60/2.85 | 1.60/2.00 | 1.55 | 1.50 | 1.50 | .235 | 21.00 |
| San Francisco | 8.75 | 13.00 | 1.80 | 2.75 | 1.10/2.00 | 1.66 | 1.90 | 1.90 | .325 | 20.50 |
| Seattle | 8.75 | 13.25 | 1.80 | 2.60 | .... | 1.81 | 1.30/2.00 | 1.75 | .35 | 28.00[f] |

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. [a] Red lead prices change frequently due to pig lead price changes. [b] U. S. War Dept. Spec. 3-49A. [c] ASTM Spec. D266-31. [d] 80% minimum ferric oxide. [e] Subject to 25% discount. [f] Distributors' price to contractors [g] 5 gal can [h] Per roll, 65 lb. [i] Minneapolis and vicinity. [j] Asphalt pitch. [k] per 100 lb. [l] per lb.

## SKILLED AND COMMON WAGE RATES—PER HOUR

| | Bricklayers | Carpenters | Struct. Iron Workers | Hoisting Engineers | Plasterers | Common Labor Building | Common Labor Heavy Const. |
|---|---|---|---|---|---|---|---|
| Atlanta | $1.25 | $1.00 | $1.375 | $1.00/1.25 | $1.375 | $0.40/.50 | $0.40/.50 |
| Baltimore | 1.50 | 1.25 | 1.65 | 1.50 | 1.25 | .5625 | .5625 |
| Birmingham | 1.50 | 1.125 | 1.25 | 1.125 | 1.00 | .30/.40[a] | .30/.40[a] |
| Boston | 1.50 | 1.375 | 1.50 | 1.625 | 1.625 | .60/.85 | .60/.85 |
| Chicago | 1.70 | 1.625 | 1.70 | 1.70 | 1.70 | 1.025 | 1.025 |
| Cincinnati | 1.625 | 1.45 | 1.525 | 1.00/1.525 | 1.625 | .60/.75 | .60/.75 |
| Cleveland | 1.625 | 1.375 | 1.50 | 1.50/1.75 | 1.50 | .90 | .90 |
| Dallas | 1.50 | 1.00 | 1.25 | 1.00 | 1.50 | .40/.50 | .40/.50 |
| Denver | 1.65[b] | 1.50[b] | 1.43[b] | .... | 1.50[b] | .718[b] | .718[b] |
| Detroit | 1.50 | 1.25 | 1.50 | 1.50 | 1.55 | 60/.75 | .60/.75 |
| Kansas City | 1.625 | 1.375 | 1.50 | 1.50 | 1.575 | .85 | .50 |
| Los Angeles | 1.25 | 1.10 | 1.375 | 1.375 | 1.50 | .625 | .625 |
| Minneapolis | 1.375 | 1.25[d] | 1.50 | 1.40 | 1.50[e] | .85 | .85 |
| New Orleans | 1.50 | 1.20 | 1.50 | 1.50 | 1.40 | .40 | .40 |
| New York | 1.90[b] | 1.75[b] | 1.925 | 2.00[b] | 2.00[c] | 1.031 | .875/.95 |
| Philadelphia | 1.65[b] | 1.25 | 1.65 | 1.50 | 1.565 | .60 | .60 |
| Pittsburgh | 1.75 | 1.50 | 1.50 | 1.25 | 1.75 | .80 | .70 |
| St. Louis | 1.50 | 1.25/1.50 | 1.75 | 1.75/2.00 | 1.58/1.75 | .45/.875 | .45/.875 |
| San Francisco | 1.75[c] | 1.25[f] | 1.50 | 1.50 | 1.60[c] | .81 | .65 |
| Seattle | 1.60[c] | 1.25 | 1.50[c] | 1.50[c] | 1.60[c] | .90[c] | .90[c] |
| Montreal | .80 | .70 | .75 | .65 | .80 | .45 | .40 |

[a] PWA. [b] 7 hr. day. [c] 6 hr. day. [d] 35 hr. wk. [e] 30 hr. wk. [f] Working under "stop-gap" agreement.




**ENR Skilled Average:** (Bricklayers, Carpenters, Ironworkers) **$1.465**
**ENR Common Average: $0.685**